

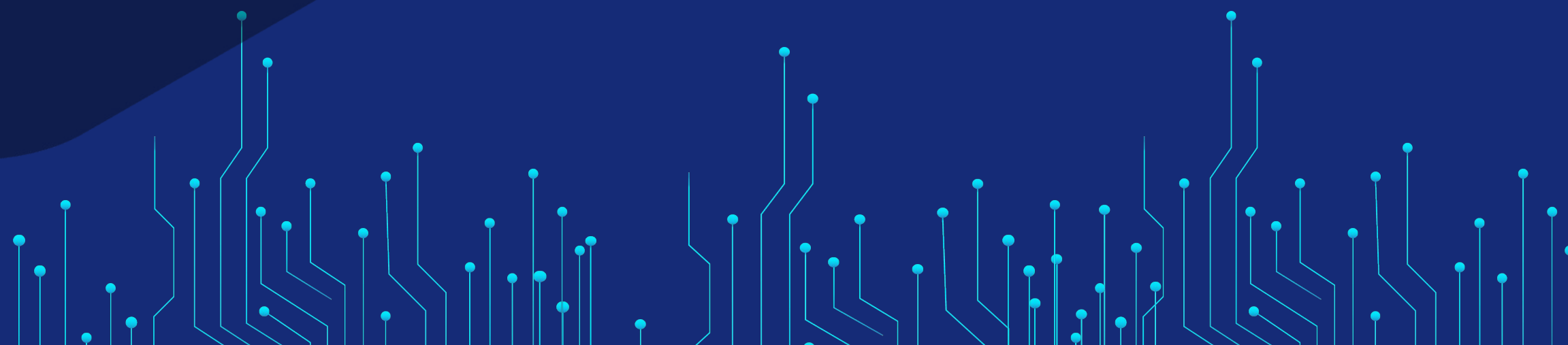


Play Geospatial Analysis with the Ease of Building Blocks

An introduction to KNIME and its
Geospatial Analytics Extension

Lingbo Liu

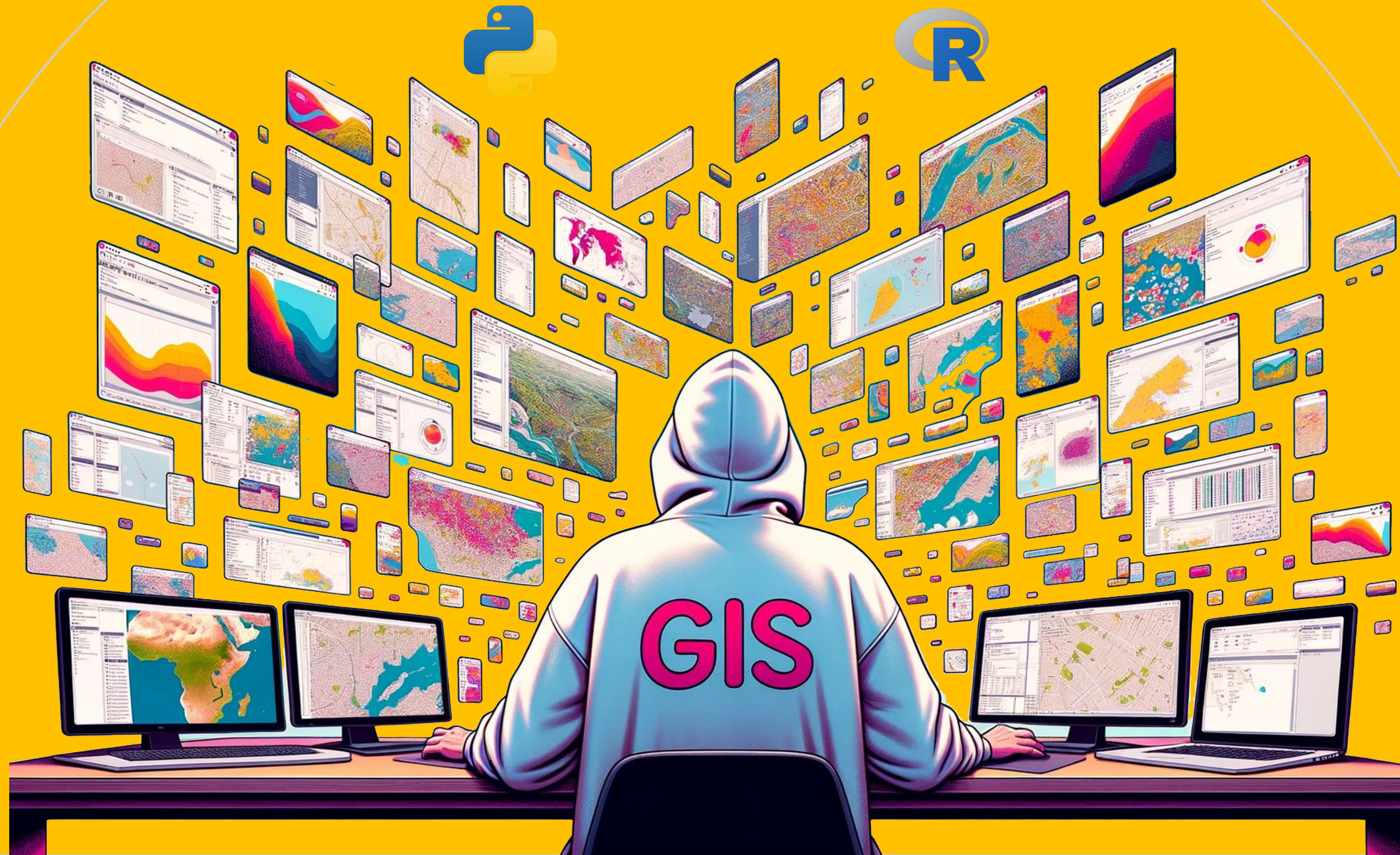
Nov. 7th, 2023



Challenges: Complexity in Spatiotemporal Analysis



Challenges: Surging Learning Curve in GIS

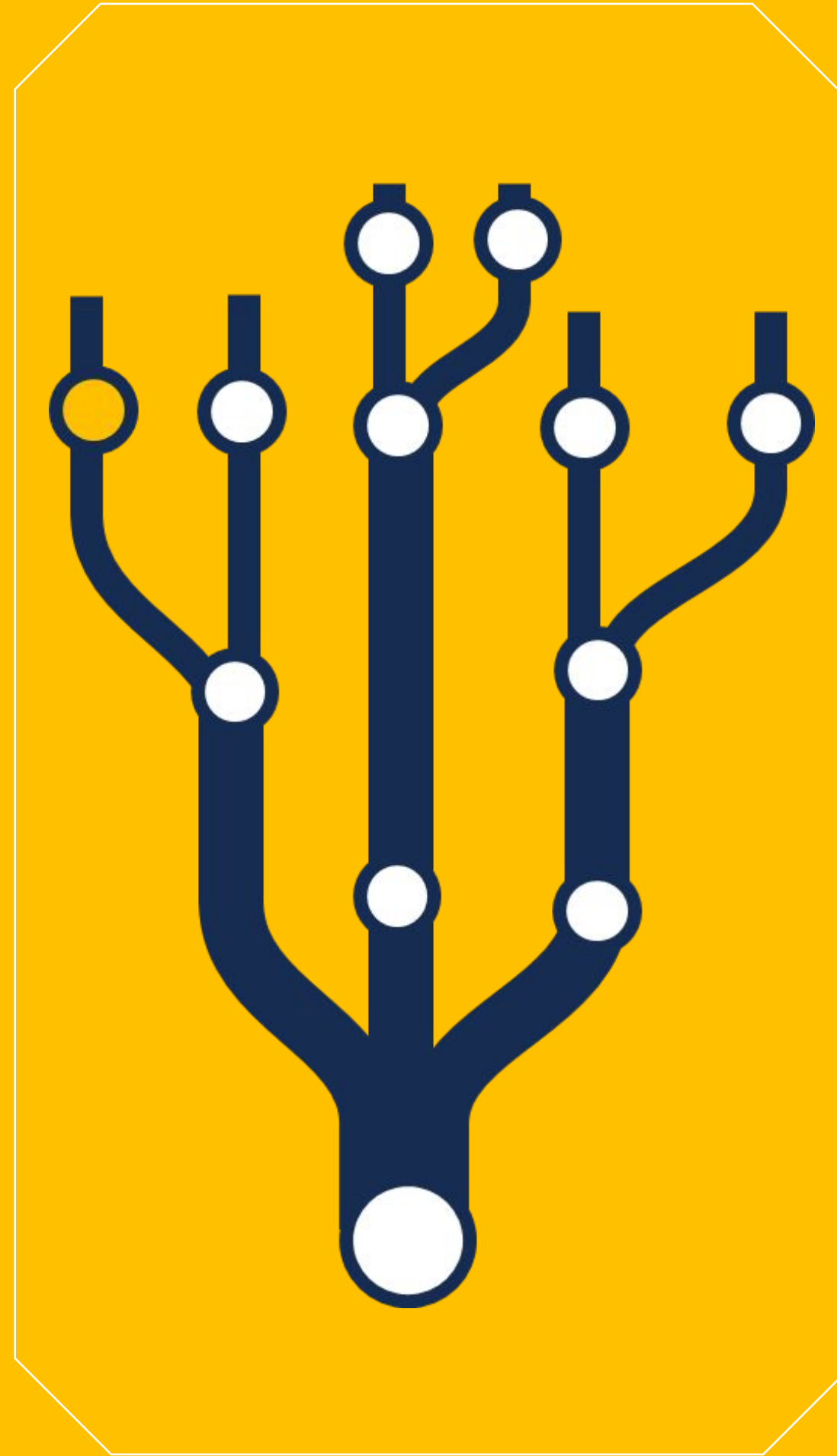


Visual Programming as Solution

Visual Programming



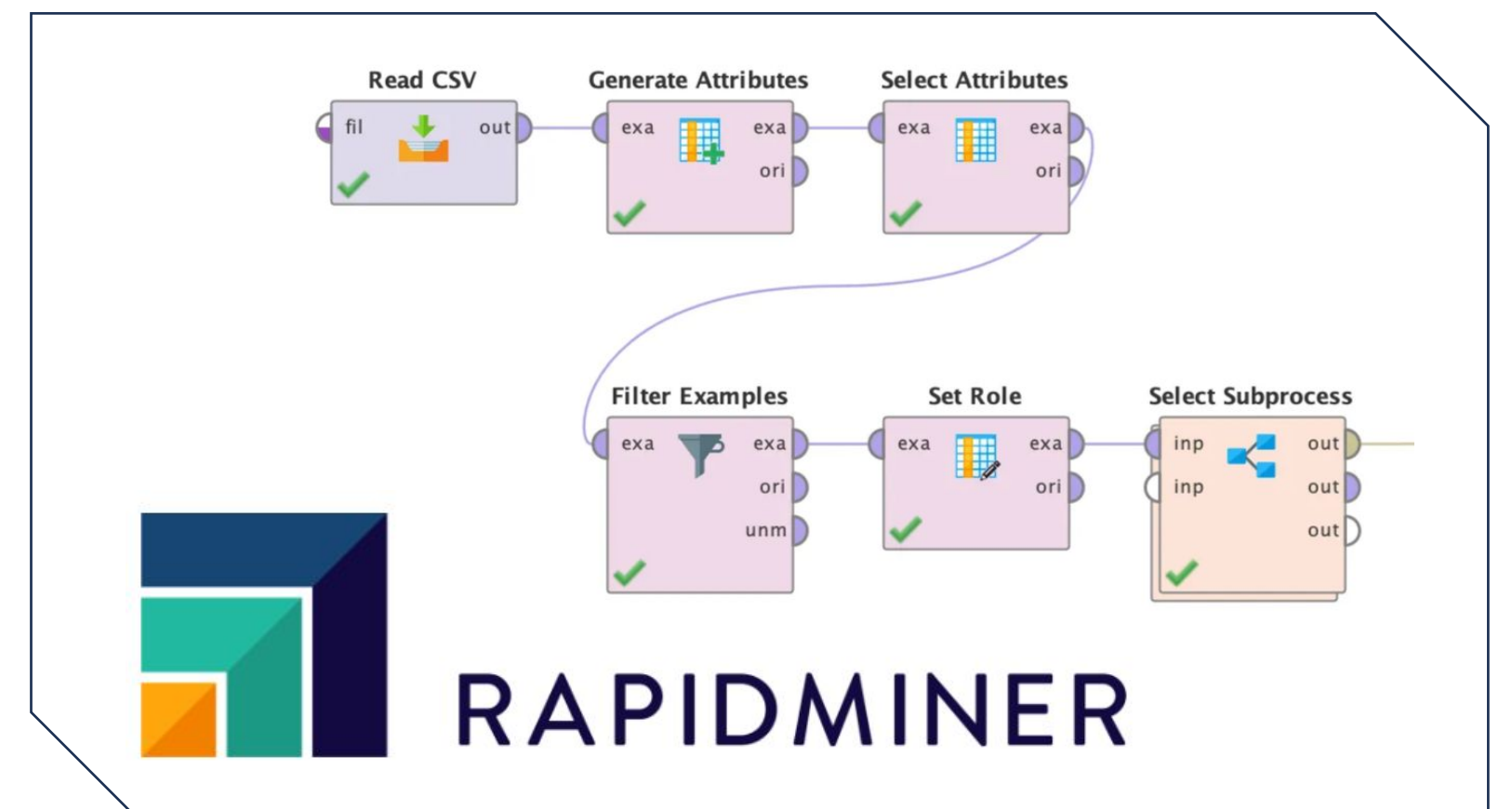
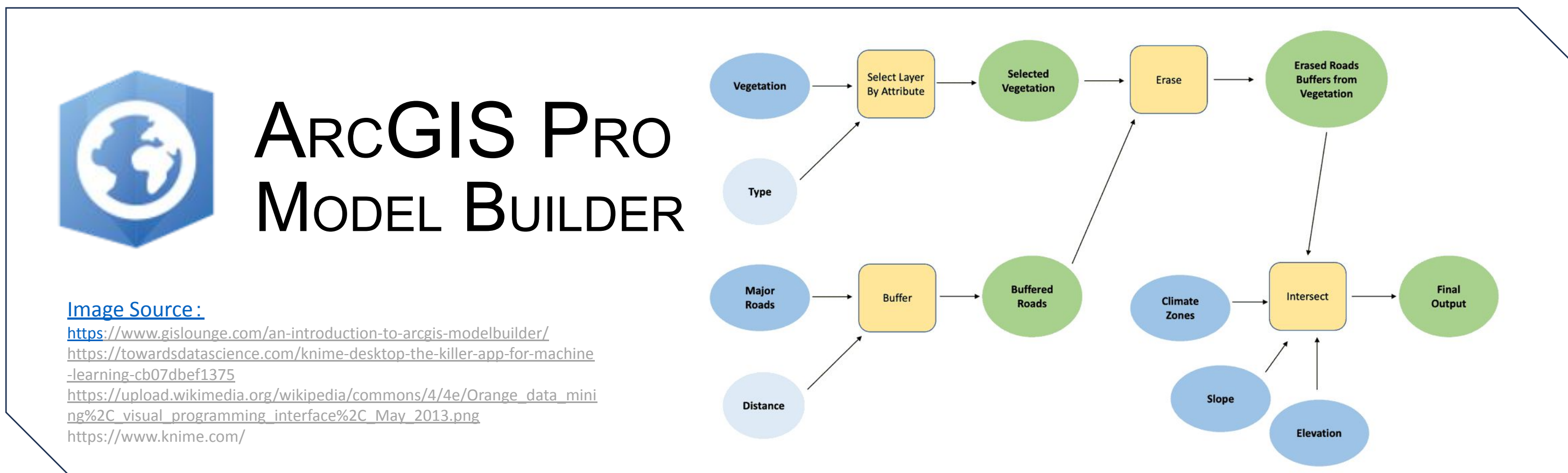
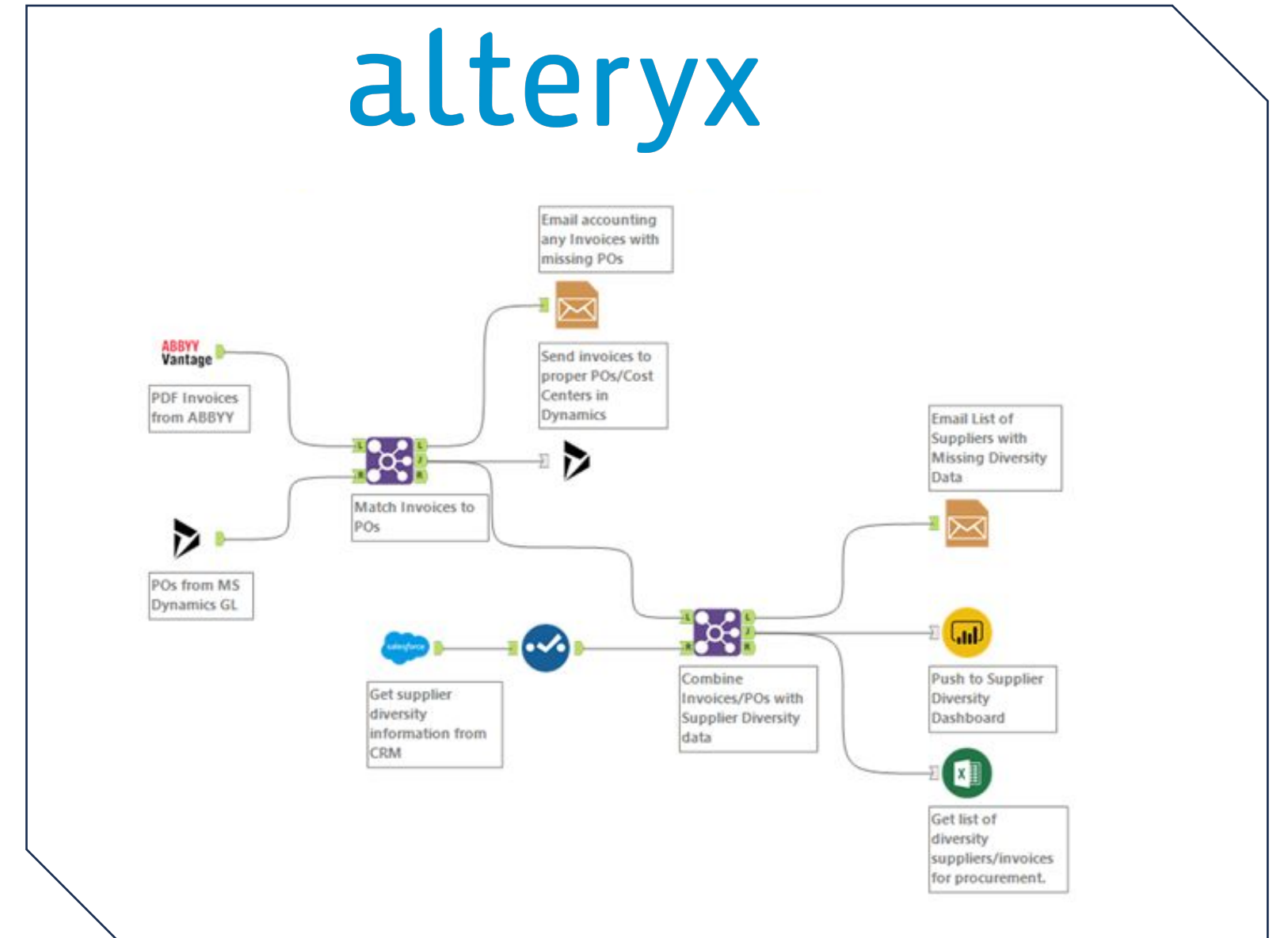
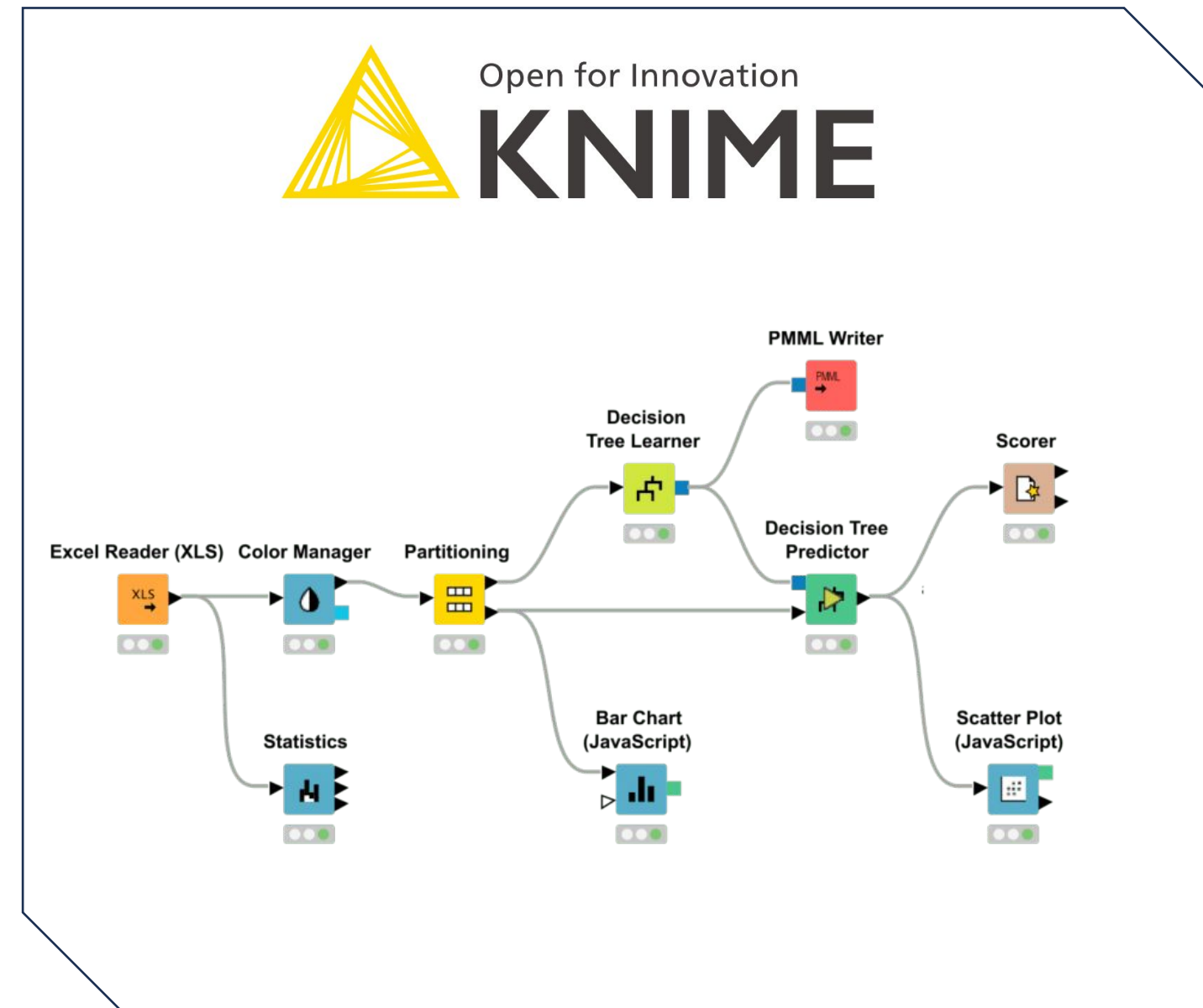
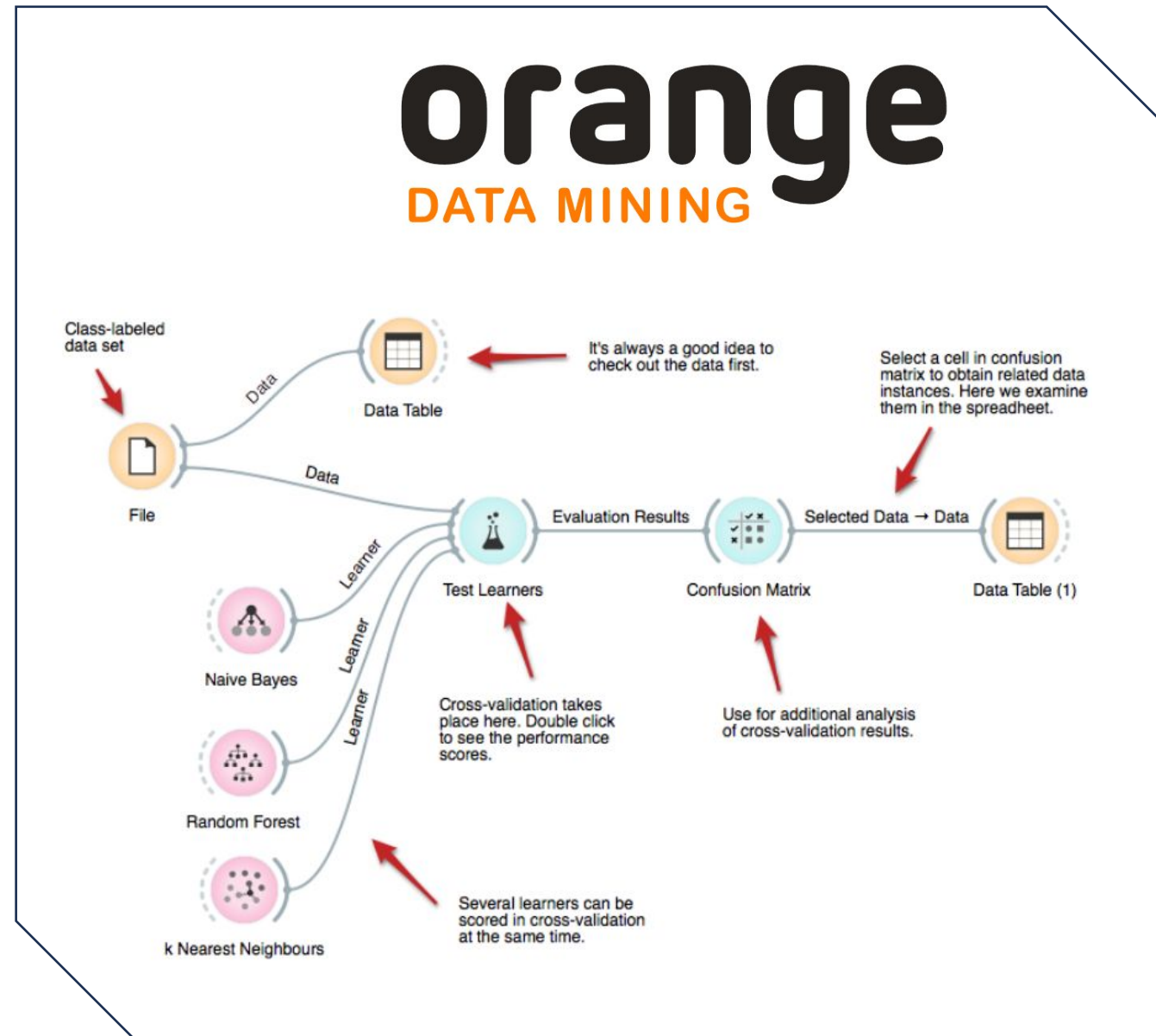
GIS Knowledge Tree



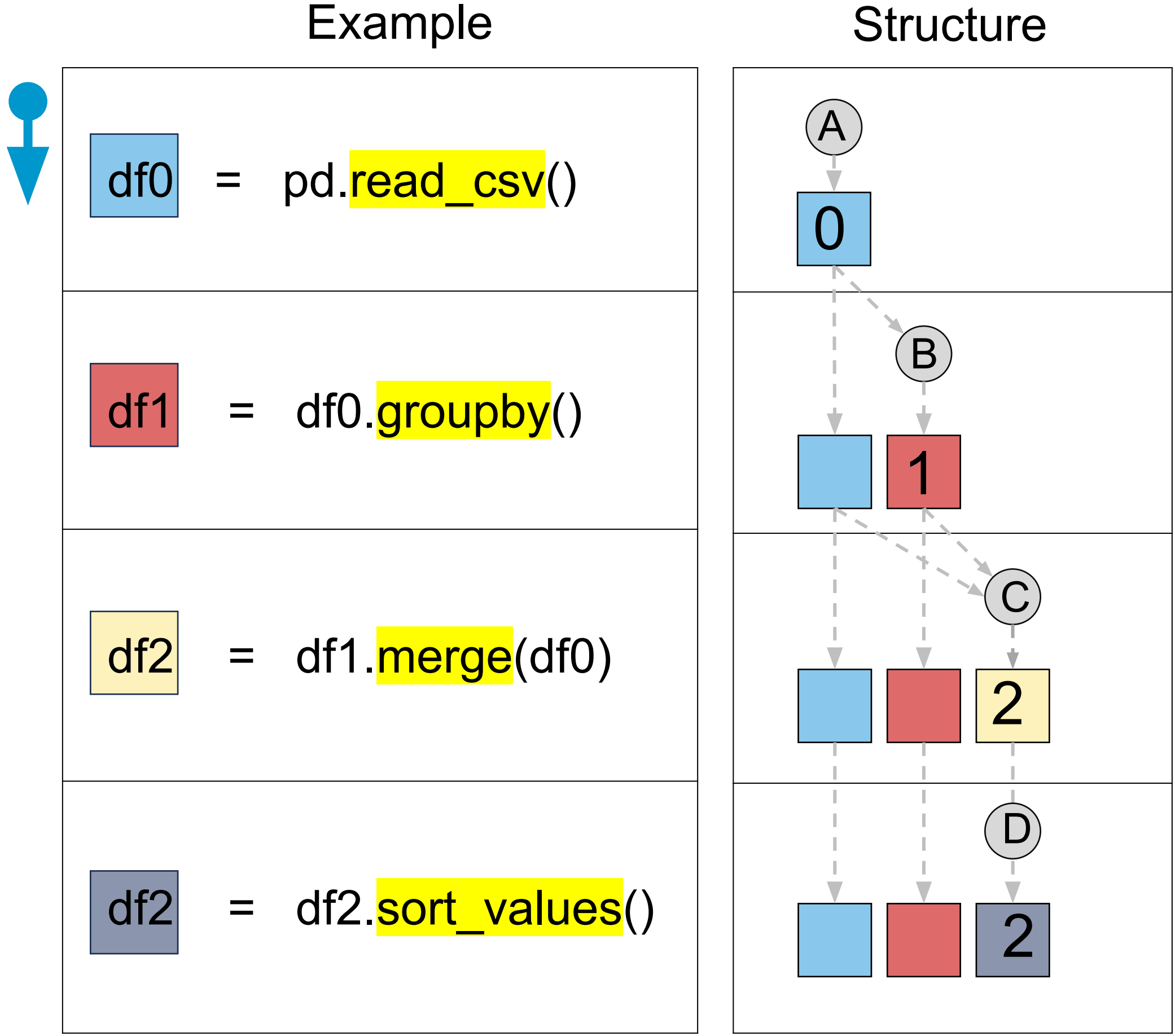
Embracing Data Science



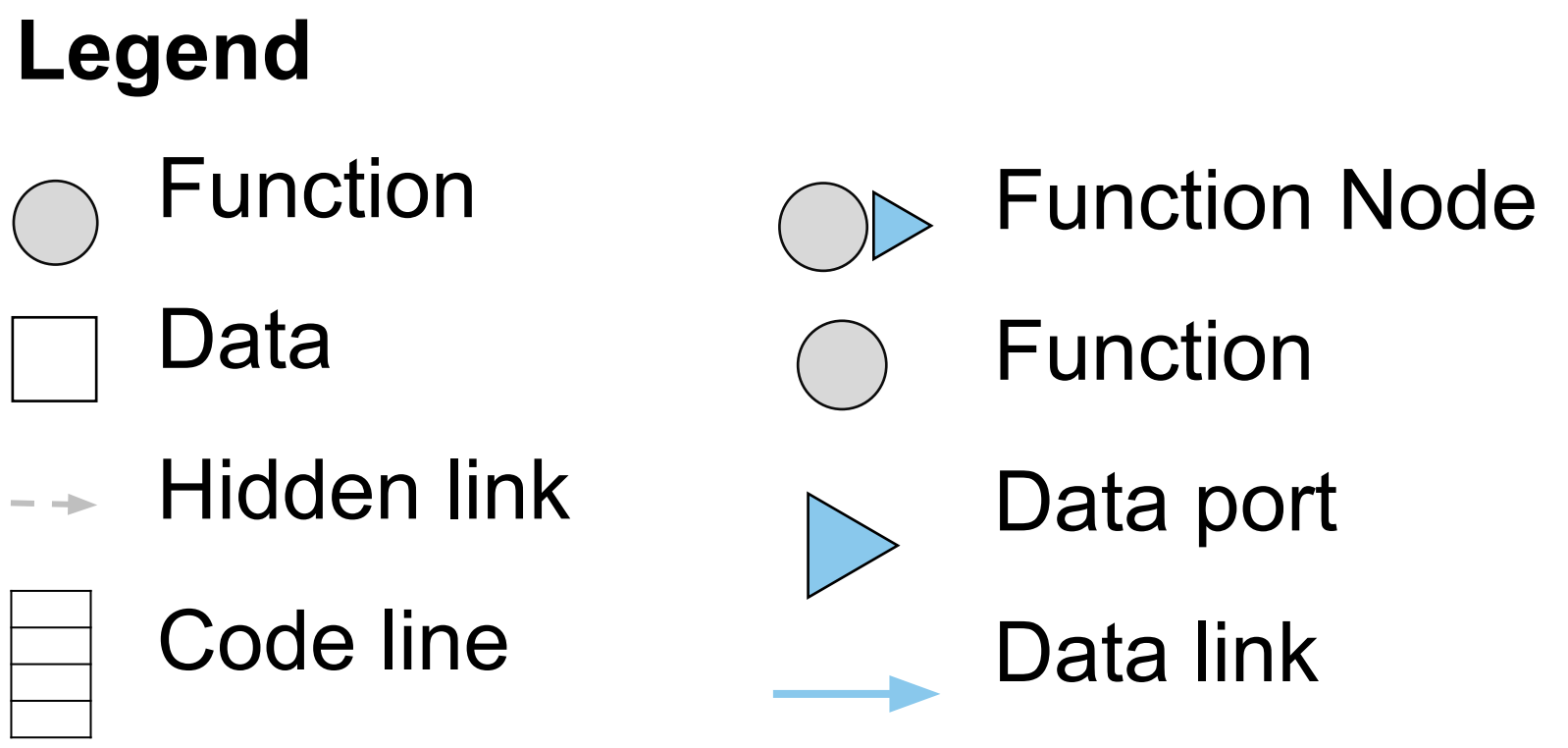
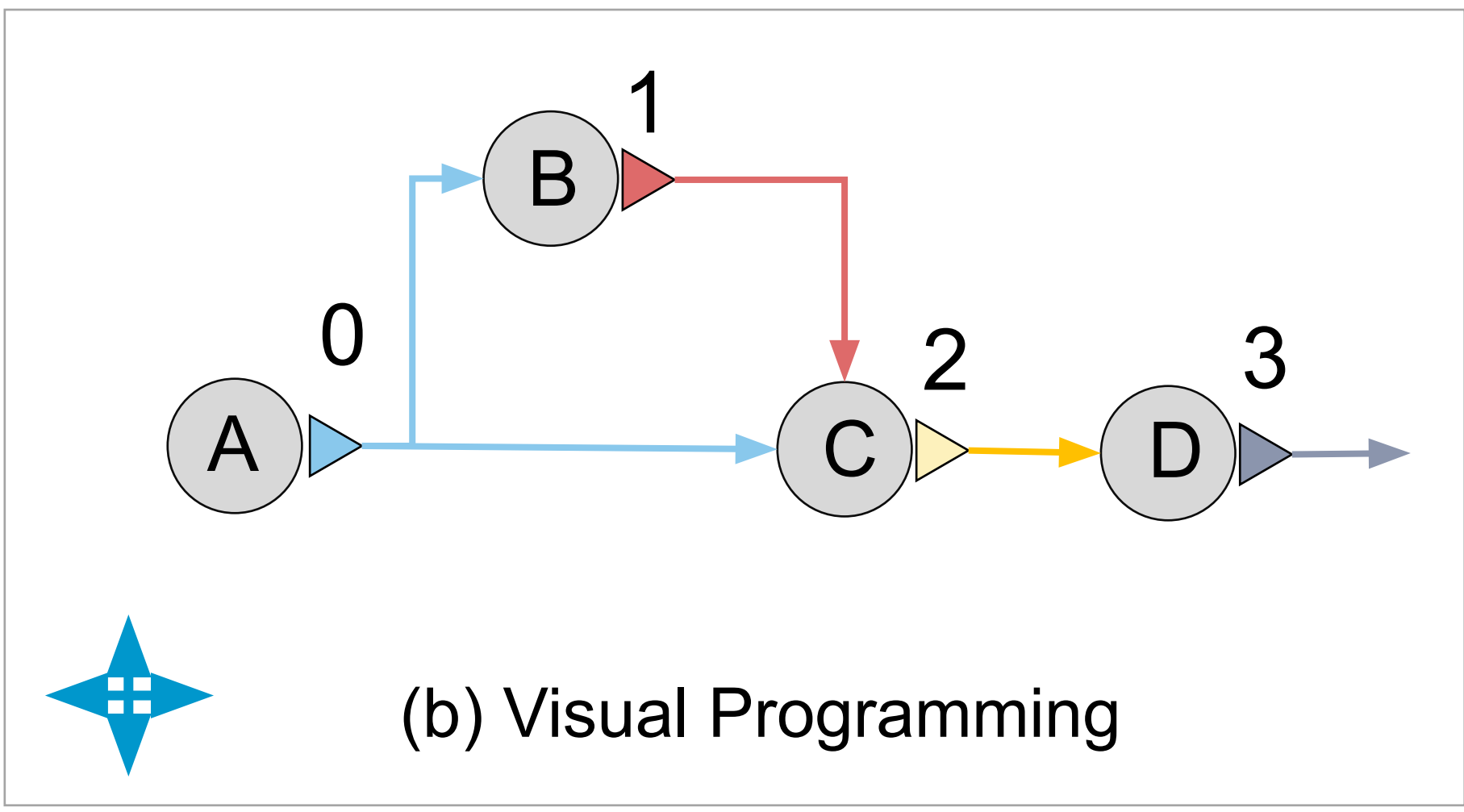
Visual Programming for Spatial Analysis



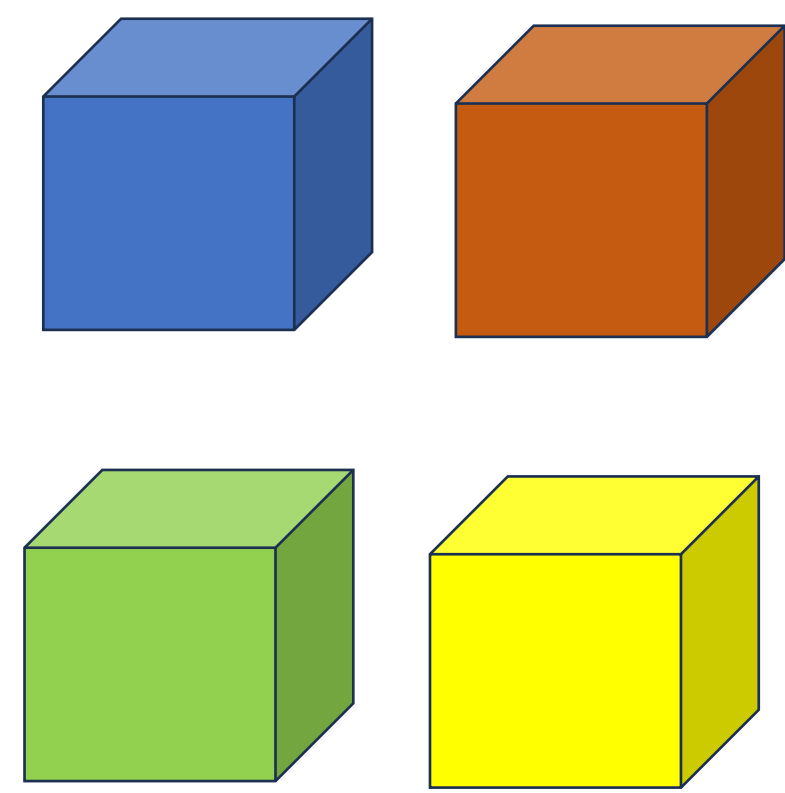
Analyst as Mind mapping in KNIME: From 1D to 2D



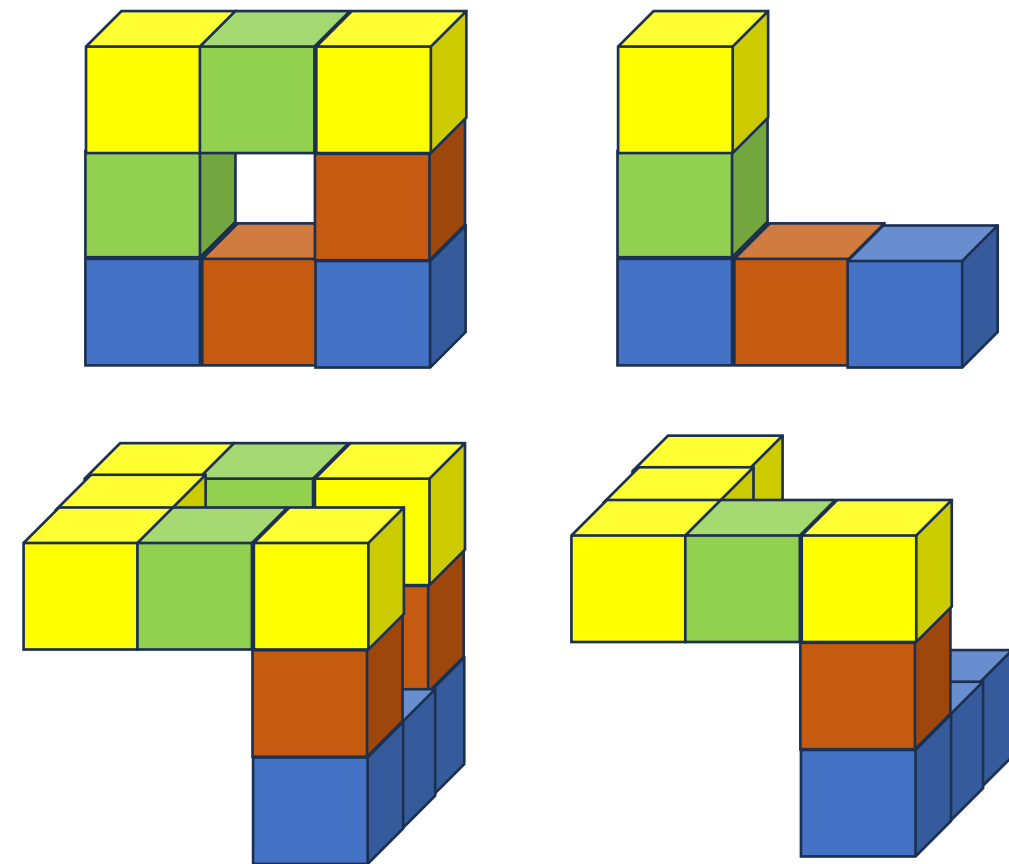
(a) Jupyter Notebook



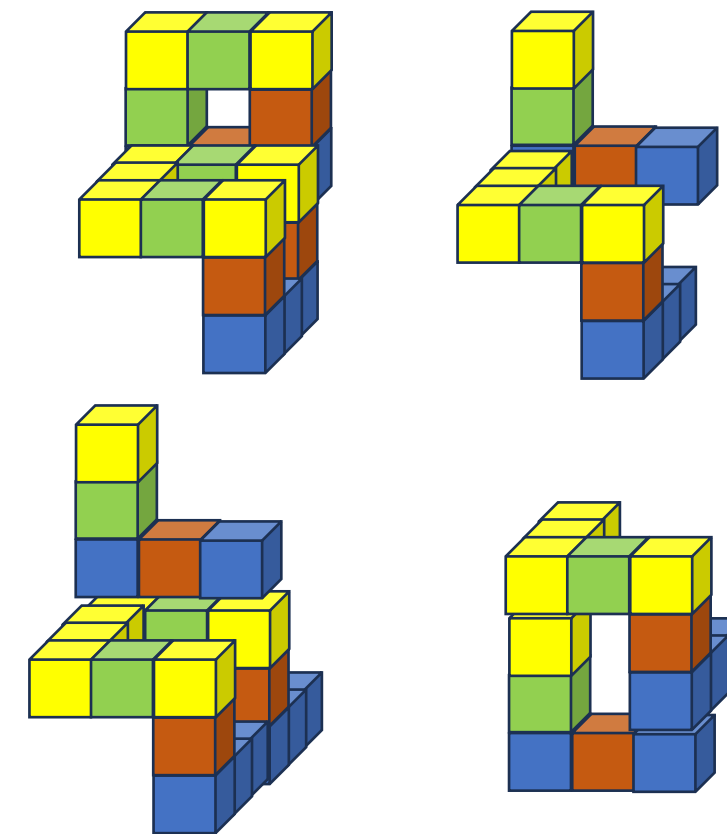
Scalability in KNIME : Nodes and Component



Single Functions



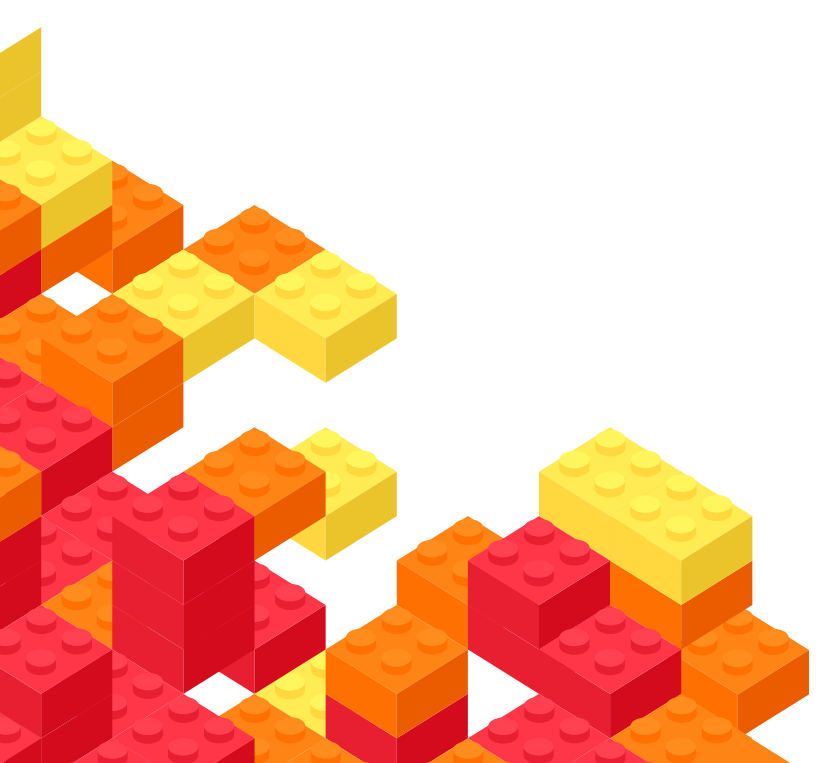
Nodes Combination as Component



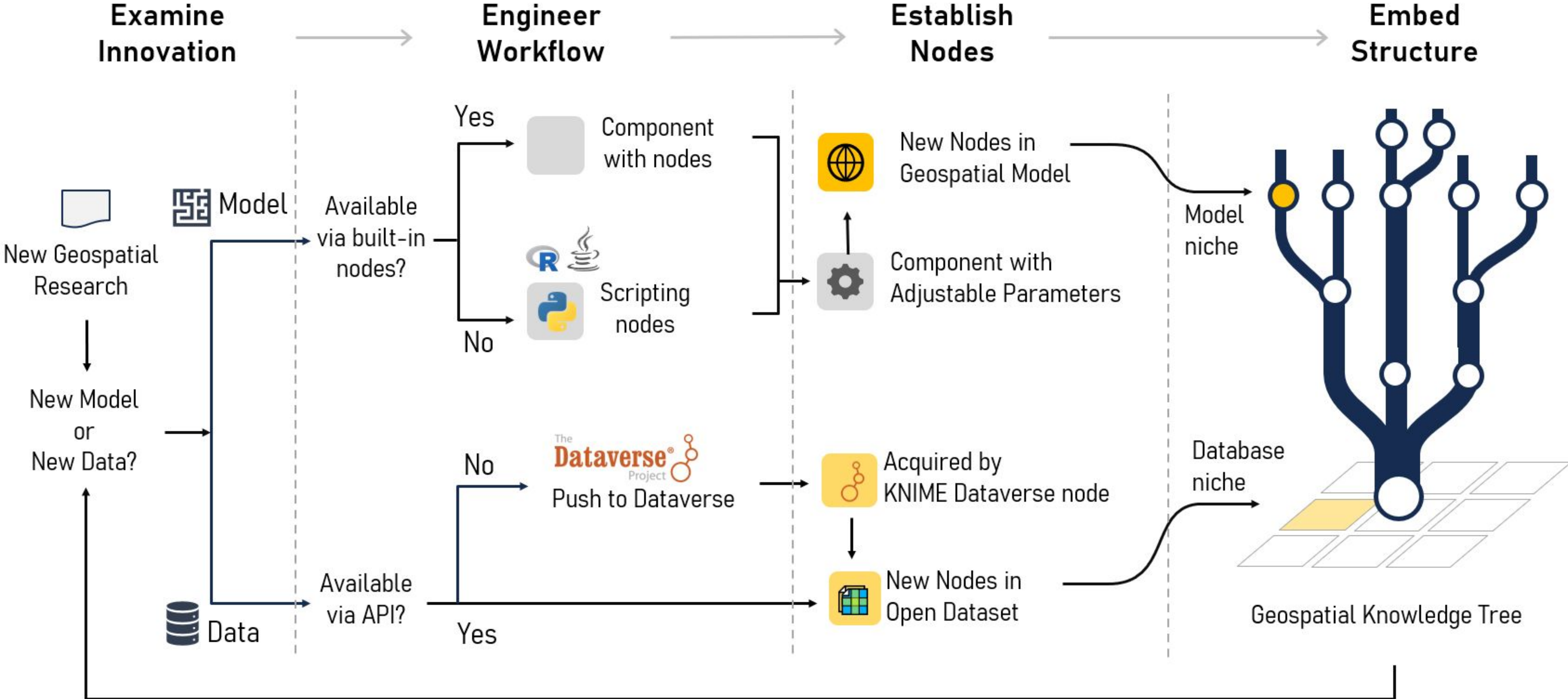
Workflows



Python Script
Python Extension



Framework for Developing Geospatial Extension





Geospatial Analytics Extension for KNIME

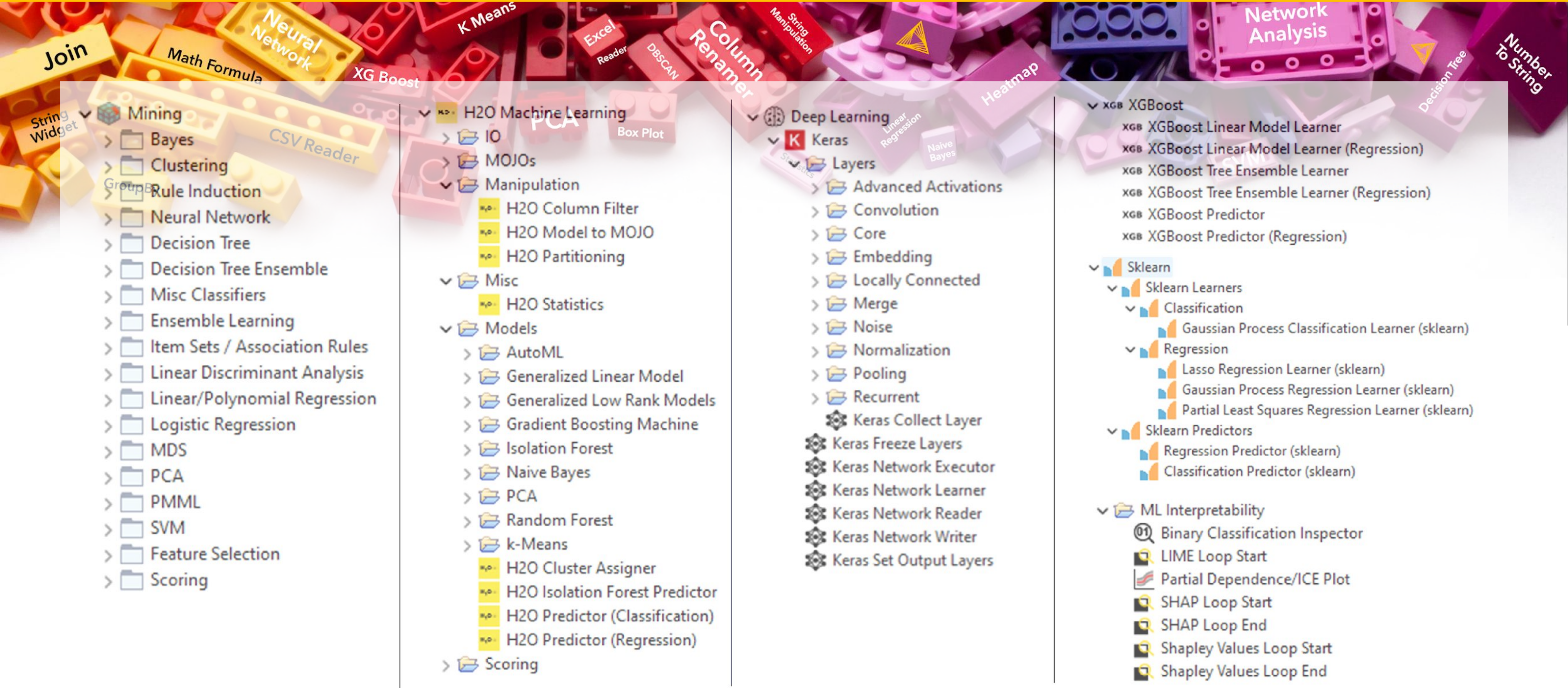


Basic Functions in KNIME

The image displays four screenshots of the KNIME software interface, showing various node categories and their sub-nodes:

- IO:** Read (Excel Reader, File Reader, File Reader (Complex Format), ARFF Reader, CSV Reader, Line Reader, Table Reader, PMML Reader, Fixed Width File Reader, Google Sheets Reader, Model Reader, Read Excel Sheet Names, Read Images, Explorer Browser), Write (CSV Writer, ARFF Writer, Table Writer, PMML Writer, Excel Cell Updater, Excel Writer, Explorer Writer, Google Sheets Writer, Google Sheets Appender, Google Sheets Updater, Model Writer, Image Writer (Port), Image Writer (Table)), Connectors (KNIME, Google, Local File System Connector, Microsoft Authenticator, OAuth2 Authenticator, OAuth2 Authenticator (Client Credentials), OAuth2 Authenticator (Password), SharePoint Online Connector).
- File Folder Utility:** Archive (zip, tar, ...), Create File/Folder Variables, Create Folder, Create Temp Folder, Delete Files/Folders, Delete Files/Folders (Table), Files/Folders Meta Info, List Files/Folders, Path to String, Path to String (Variable), Path to URI, Set Files/Folders Permissions, String to Path, String to Path (Variable), Transfer Files, Transfer Files (Table), Other (Binary Objects, URI), Data Generator, Create Table Structure, Send Email, Extract System Properties, Extract Context Properties, Find MIME-Type, List MIME-Types, Table Creator, Variable Creator, File Handling (legacy) (Remote (legacy), Zip (legacy), Copy/Move Files (legacy), Create File Name (legacy), File Meta Info (legacy)), Cache.
- Manipulation:** Column (Binning, Convert & Replace (Category To Number, Category To Number (Apply), Column Auto Type Cast, Column Renamer, Column Rename (Regex), Constant Value Column, Math Formula, Math Formula (Multi Column), Number To Category (Apply), Number To String, String To Number, Double To Integer, Round Double, String Manipulation, String Manipulation (Multi Column), String Replacer, Domain Calculator, Edit Numeric Domain, Edit Nominal Domain (Dictionary), Edit Nominal Domain, String Replacer (Dictionary), Target Shuffling), Filter (Column Filter, Reference Column Filter, Constant Value Column Filter, Missing Value Column Filter, Reference Column Splitter).
- Split & Combine:** Cell Splitter, Cell Splitter By Position, Column Aggregator, Column Combiner, Column Merger, Column Splitter, Column Appender, Column to Grid, Create Bit Vector, Expand Bit Vector, Create Collection Column, Split Collection Column, Create Byte Vector, Expand Byte Vector, Joiner, Cross Joiner, Nominal Probability Distribution Creator, Nominal Probability Distribution Splitter, Regex Split, Value Lookup, Transform (f-F Case Converter, Column Comparator, Column Resorter, Lag Column, Reference Column Resorter, Denormalizer, Extract Missing Value Cause, Missing Value, Missing Value (Apply), Normalizer, Normalizer (Apply), One to Many, Many to One, SMOTE, Set Operator, Subset Matcher), Interactive HiLite Collector, Table Manipulator, Table Validator, Table Validator (Reference).
- Views:** JavaScript (Generic JavaScript View (JavaScript), Bar Chart (JavaScript), Box Plot (JavaScript), Conditional Box Plot (JavaScript), Decision Tree View (JavaScript), Heatmap (JavaScript), Histogram (JavaScript), Lift Chart (JavaScript), Line Plot (JavaScript), Parallel Coordinates Plot (JavaScript), Pie/Donut Chart (JavaScript), ROC Curve (JavaScript), Scatter Plot (JavaScript), Stacked Area Chart (JavaScript), Sunburst Chart (JavaScript), Table Editor (JavaScript), Table View (JavaScript), Tag Cloud (JavaScript), Tile View (JavaScript)), Property, Local (Swing), Utility, Visualization Column Appender (Bar Chart, Box Plot, Density Plot, Heatmap, Histogram, Line Plot, Parallel Coordinates Plot, Pie Chart, ROC Curve, Scatter Plot, Scatter Plot Matrix, Stacked Area Chart, Statistics, Sunburst Chart, Table View).
- DB:** Other Data Types, Structured Data (JSON, XML), Scripting (Conda, Java, Python (Python Script, Python View, Python (legacy) (Python Edit Variable (legacy), Python Source (legacy), Python Script (legacy), Python View (legacy), Python Object Reader (legacy), Python Object Writer (legacy), Python Learner (legacy), Python Predictor (legacy)), Tools & Services (Google Analytics, REST Web Services), Community Nodes, KNIME Labs (JavaScript Views (Labs), Parallel Execution, Molecule Widget (Labs), Row Filter (Labs), Row Splitter (Labs)), Workflow Control (Automation, Variables, Loop Support, Switches, Error Handling, Meta Nodes), Workflow Abstraction (Workflow Invocation, Configuration, Widgets, Quickforms (legacy)), Reporting (Data to Report, Image to Report).

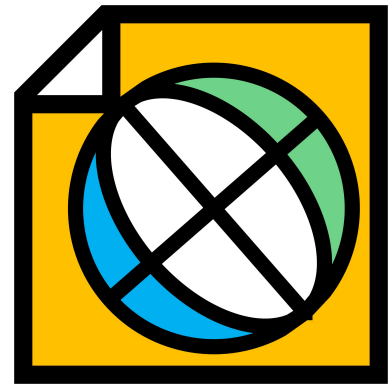
Advanced Functions in KNIME



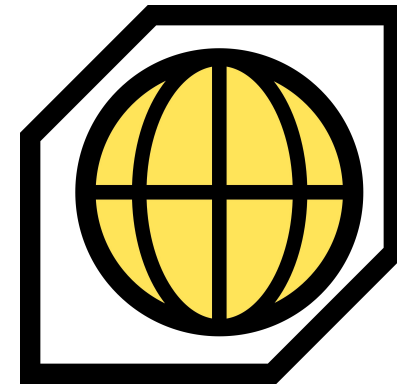


Geospatial Analytics Extension For KNIME

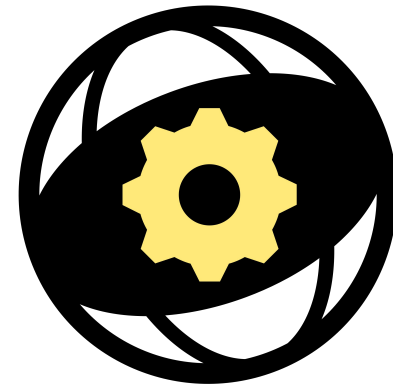
Latest Version 1.2.0



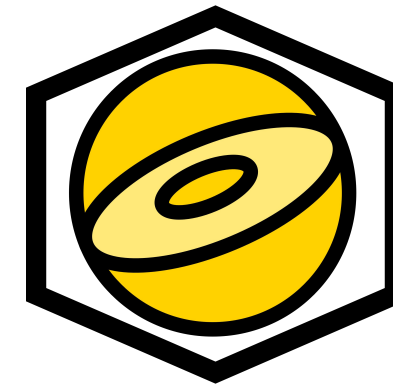
Spatial IO



Spatial Calculation



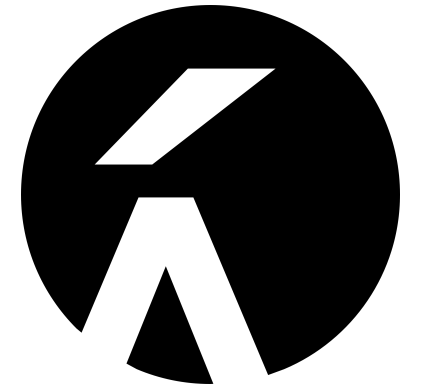
Spatial Manipulation



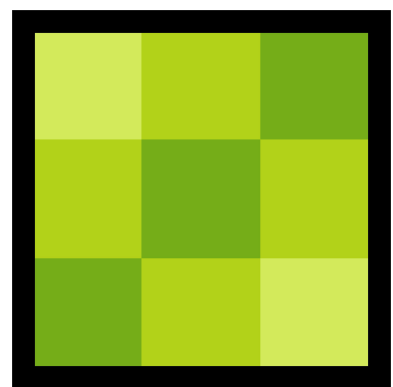
Spatial Transformation



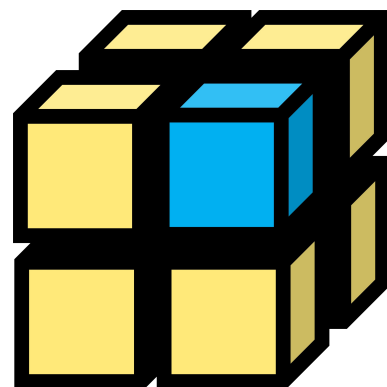
Spatial Conversion



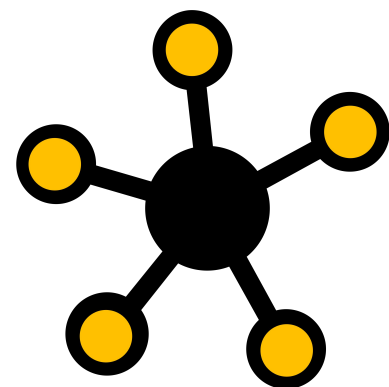
Spatial Visualization



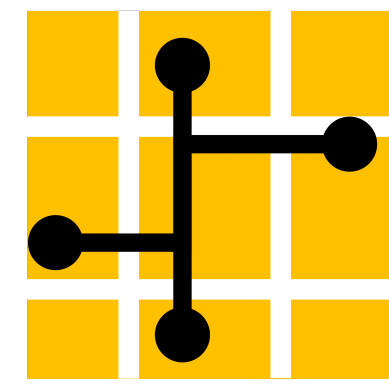
Exploratory Spatial Data Analysis



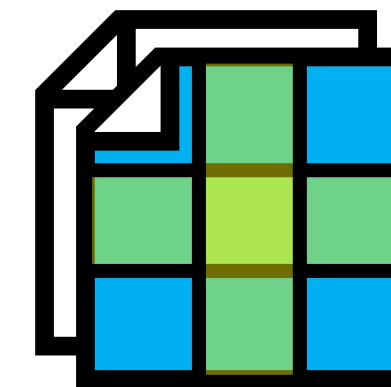
Spatial Modelling



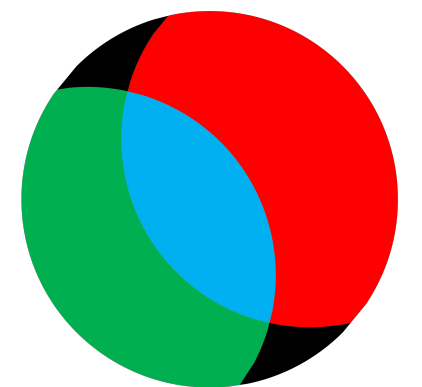
Location Analysis



Spatial Network



Open Dataset



Spatial Clustering





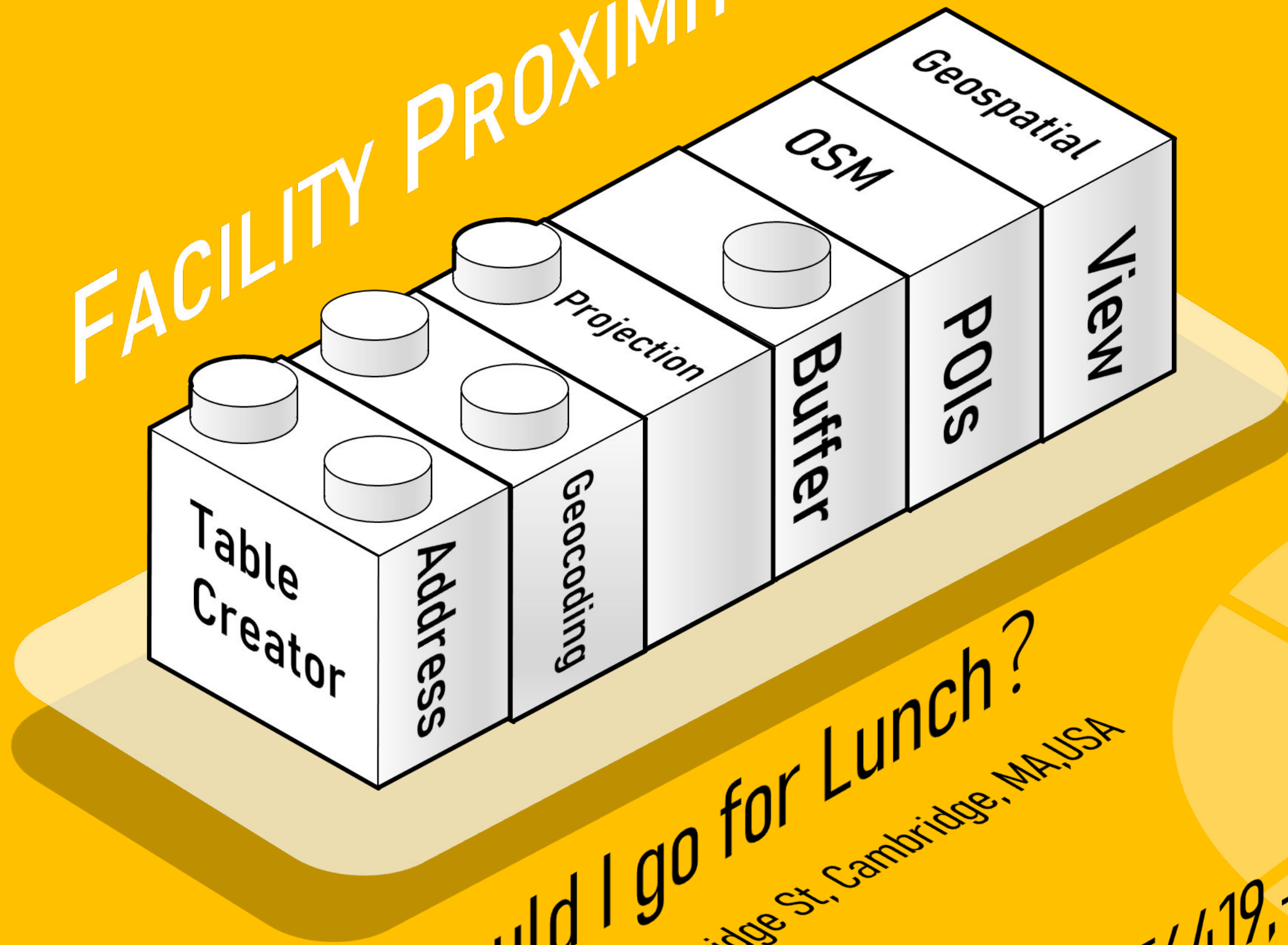
Geospatial Analytics Extension For KNIME

Latest Version 1.2.0

- ▼ Spatial IO
 - GeoFile Reader
 - GeoFile Writer
 - GeoPackage Reader
 - GeoPackage Writer
- ▼ Spatial Calculation
 - Area
 - Bounding Box
 - Bounding Circle
 - Bounds
 - Convex Hull
 - Coordinates XYZ
 - Length
 - Line Endpoints
 - Total Bounds
 - Unary Union
- ▼ Spatial Manipulation
 - Buffer
 - Clip
 - Create Grid
 - Dissolve
 - Euclidean Distance
 - Haversine Distance
 - Multiple Ring Buffer
 - Nearest Join
 - Overlay
 - Simplify
 - Spatial Join
 - Voronoi (Thiessen) Polygon
- ▼ Spatial Transformation
 - Create Random Points
 - Geometry To Point
 - Line To MultiPoint
 - Multipart To Singlepart
 - Points To Line
 - Polygon To Line
 - Projection
- ▼ Spatial Conversion
 - GeoJSON to Geometry
 - Geocoding
 - Geometry to GeoJSON
 - Geometry to Lat/Long
 - Geometry to Metadata
 - Geometry to WKT
 - IP to Geometry
 - Lat/Lon to Geometry
 - Reverse Geocoding
 - WKT to Geometry
- ▼ Spatial Visualization
 - Geospatial View
 - Geospatial View Static
 - Kepler.gl Geoview
 - Spatial Heatmap
- ▼ Exploratory Spatial Data Analysis
 - Global Geary's C
 - Global Getis-Ord G
 - Global Moran's I
 - Local Getis-Ord G
 - Local Moran's I
 - Spatial Weights
- ▼ Spatial Modelling
 - 2SLS with Spatial Test
 - GWR Model
 - GWR Predictor
 - MGWR Model
 - OLS with Spatial Test
 - Spatial Error Model
 - Spatial Error Panel Model
 - Spatial Lag Model
 - Spatial Lag Panel Model
- ▼ Location Analysis
 - LSCP
 - LSCP Solver
 - MAEP Solver
 - MCLP
 - MCLP Solver
 - P-center Solver
 - P-median
 - P-median Solver
- ▼ Open Datasets
 - OSM Boundary Map
 - OSM POIs
 - OSM Road Network
 - ACS US ACS 5-Year Estimates
 - US2020 Census Data
 - US2020 TIGER Map
- ▼ Spatial Clustering
 - MSSC Initialization
 - MSSC Refiner
 - AZP
 - Isolation Tackler
 - MaxP
 - Mean Center
 - Peano Curve
 - REDCAP
 - SCHC
 - SKATER
 - Standard Deviation Ellipse
- ▼ Spatial Network
 - Google Distance Matrix
 - OSRM Distance Matrix
 - Road Network Distance Matrix
 - Road Network Isochrone Map

Case study 1: Find Nearest Restaurant

FACILITY PROXIMITY

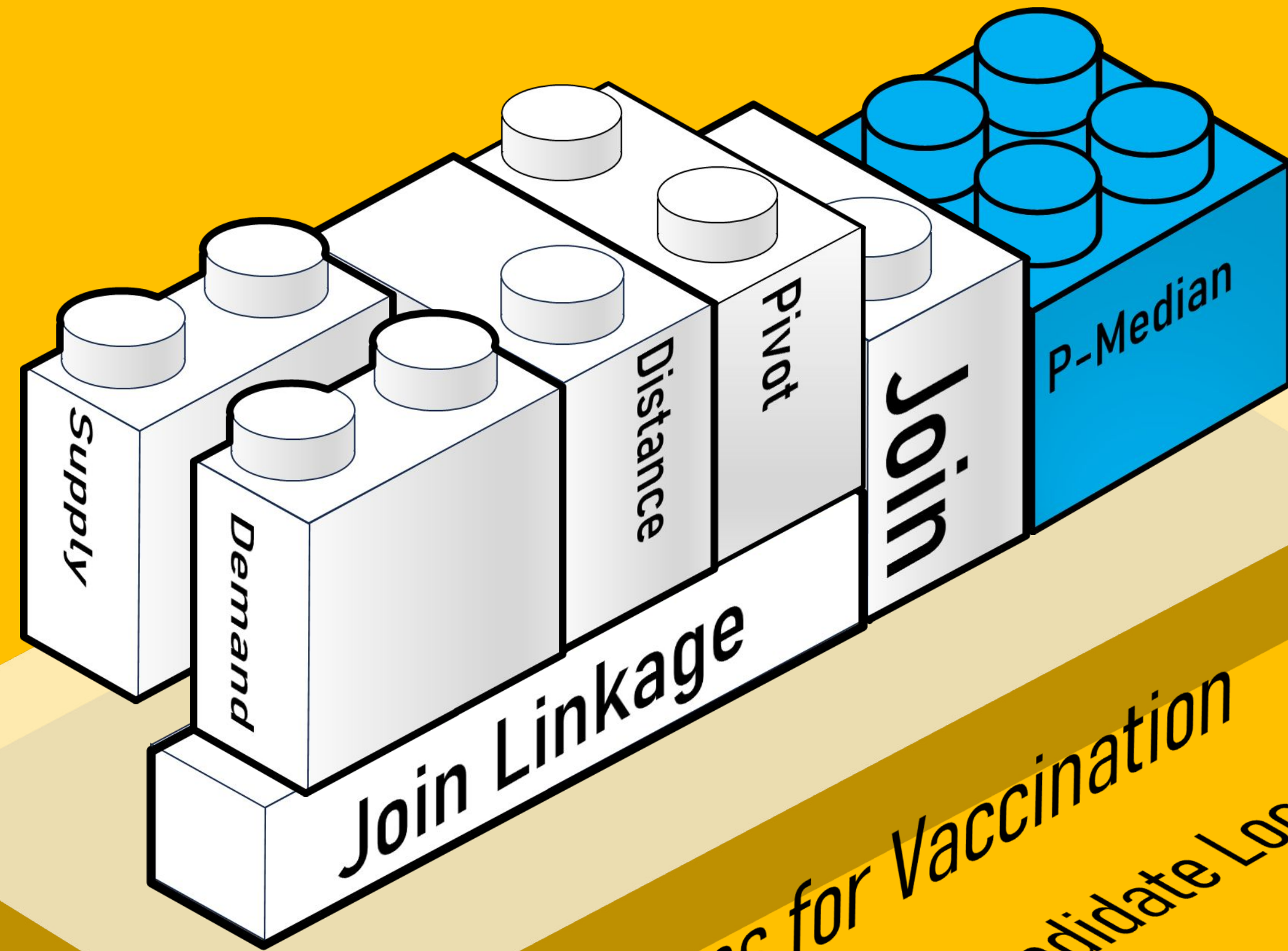


Where should I go for Lunch?
1737 Cambridge St, Cambridge, MA, USA

42.3756419, -71.1158105



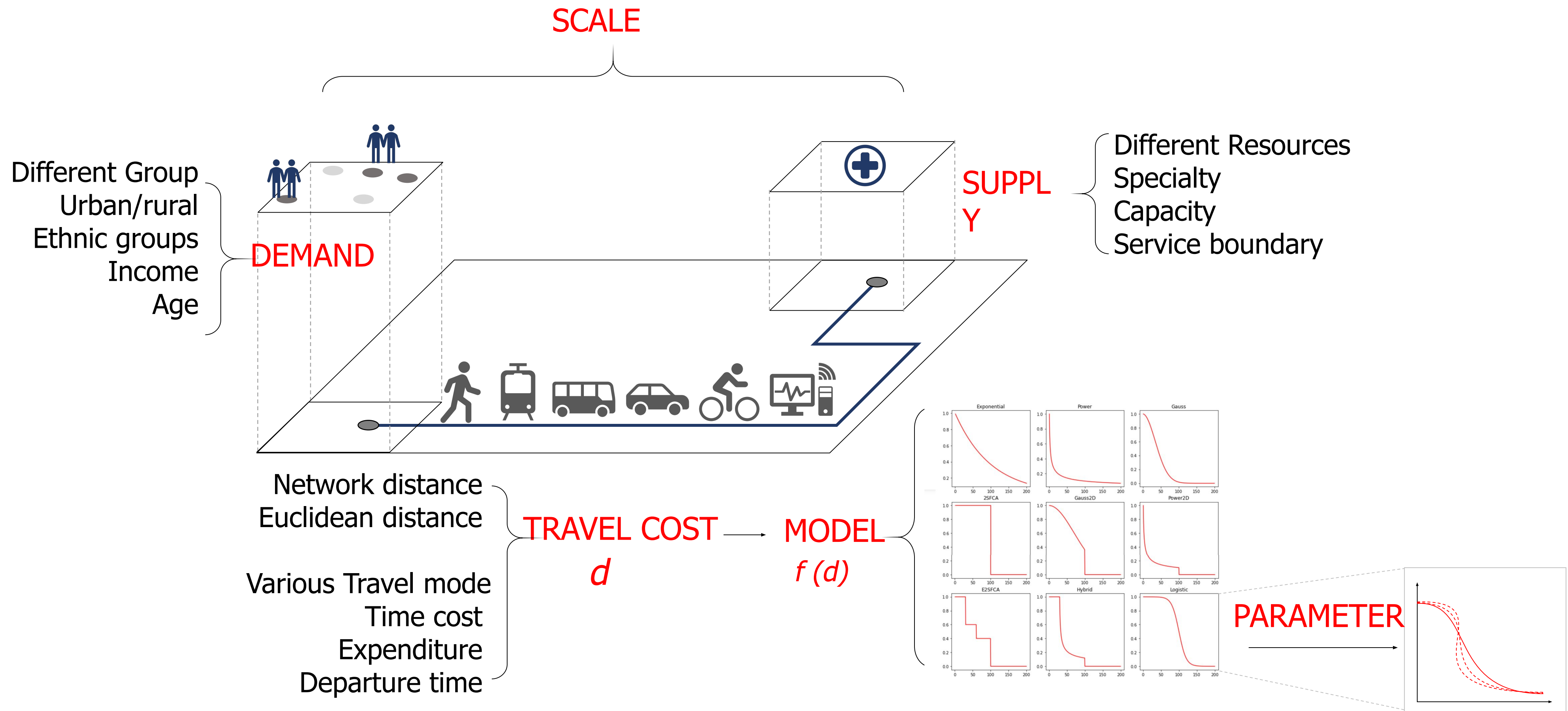
Case study 2: location-allocation



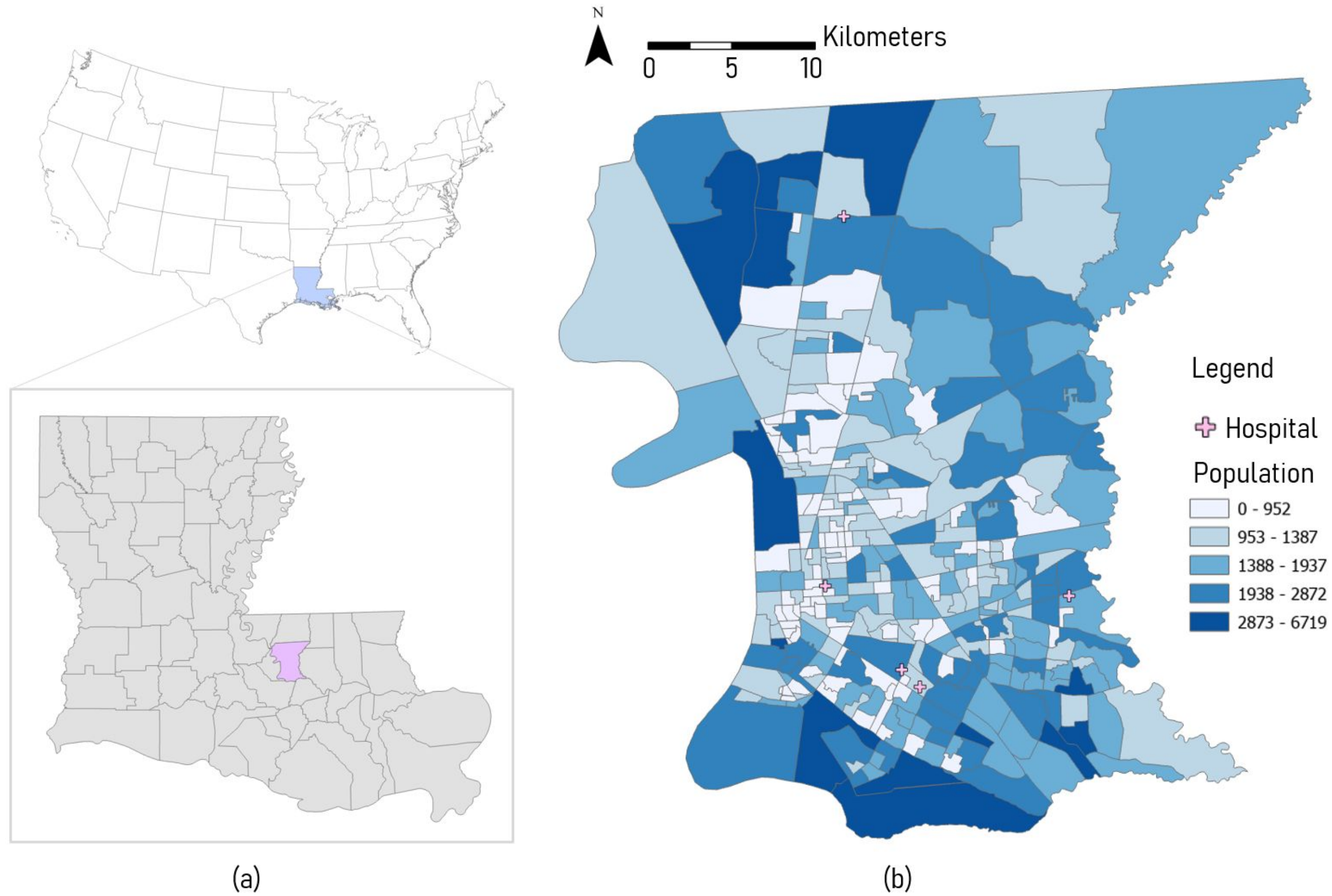
Choose 3 Locations for Vaccination
6 Demand, 6 Candidate Location



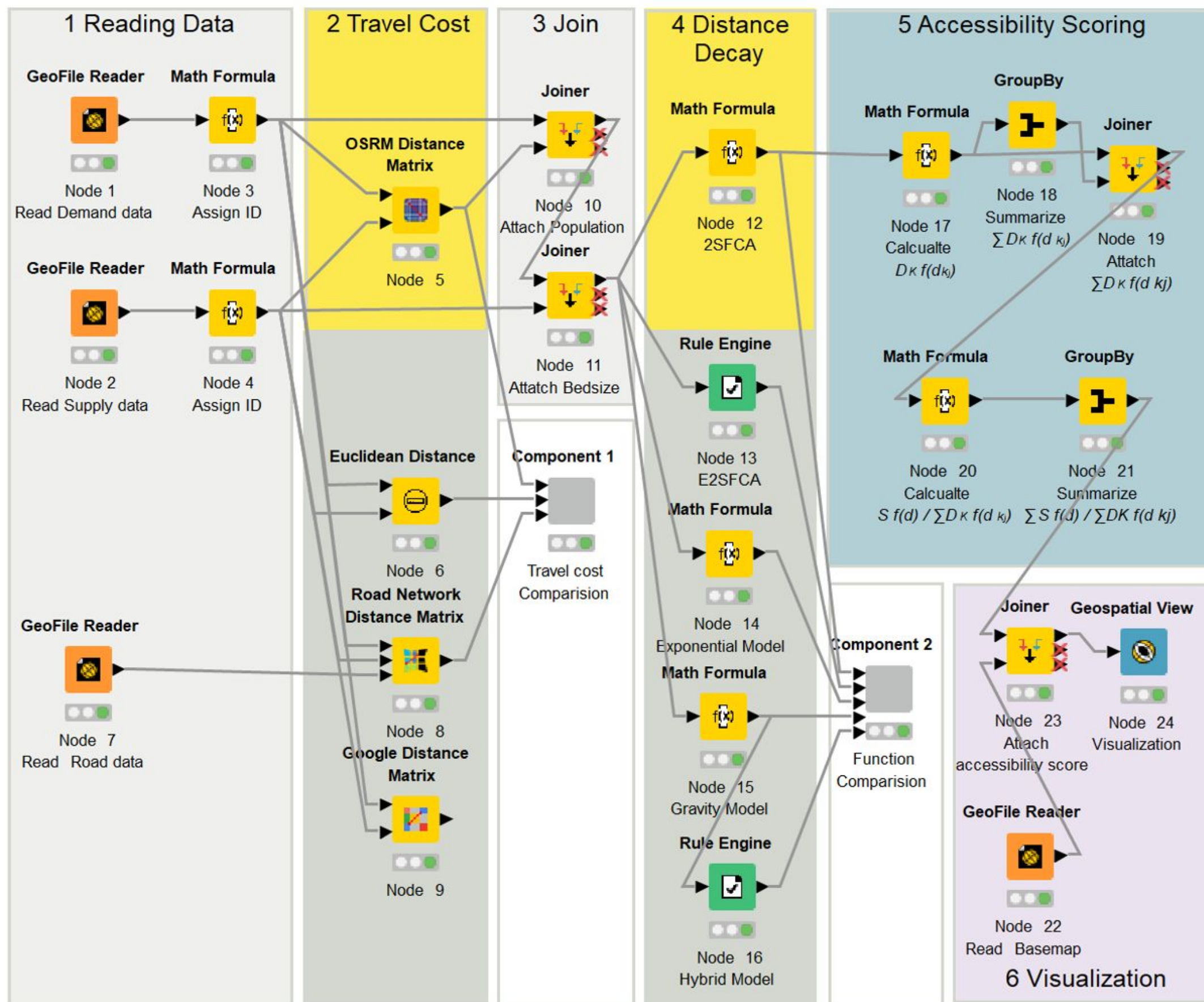
Case study 3: Healthcare Accessibility



Case study 3: Healthcare Accessibility



KNIME workflow for implementing G2SFCA



- Legend
- Standard steps (light grey)
 - Expandable steps (yellow)
 - Expandable nodes (dark grey)
 - Core Model (blue)
 - Visualization (purple)

Dialog - 3:4 - Math Formula (Node 4)

Math Expression: $1 \text{ } \$\$ROWINDEX\$\$+1$

Append Column: DID

Distance Decay Function

Expression: $1 \text{ } \$Duration\≤ 25

Append Column: f(d)

Expression: $1 \text{ } \exp((-1)*\$Duration\$\)$

Append Column: SID

Expression: $1 \text{ } \$Duration\$\cdot(-1)$

Append Column: Ppotent

Expression: $1 \text{ } \$Popu2020\$\cdot\$f(d)\$$

Append Column: drcopR

Expression: $1 \text{ } 1000*\$Bed_size\$\cdot\$f(d)\$/\$Sum(Ppotent)\$$

(a) (b) (c) (d) (e) (f)

Apply G2SFCA Model

Dialog - 3:13 - Rule Engine (Node 13)

Rule Editor

Column List: ROWID, ROWINDEX, ROWCOUNT, GEOID, Popu2020, Origin ID, Destination ID, Duration, Distance, Bed_size

Function: ? < ? , ? <= ? , ? = ? , ? > ? , ? >= ? , ? AND ? , ? IN ? , FALSE, MISSING ?

Expression:

```

1 | 1 | $Duration$ <= 10 => 1
D | 2 | $Duration$ > 10 AND $Duration$ <= 25 => 0.5
I | 3 | $Duration$ > 25 => 0

```

Append Column: f(d)

Replace Column: D Distance

(a)

Expression:

```

I | 1 | $Duration$ <= 5 => 1
D | 2 | $Duration$ > 5 => $f(d)$

```

Append Column: f(d)

Replace Column: D f(d)

(b)

Figure 6 . KNIME workflow for G2SFCA model

Component in KNIME workflow

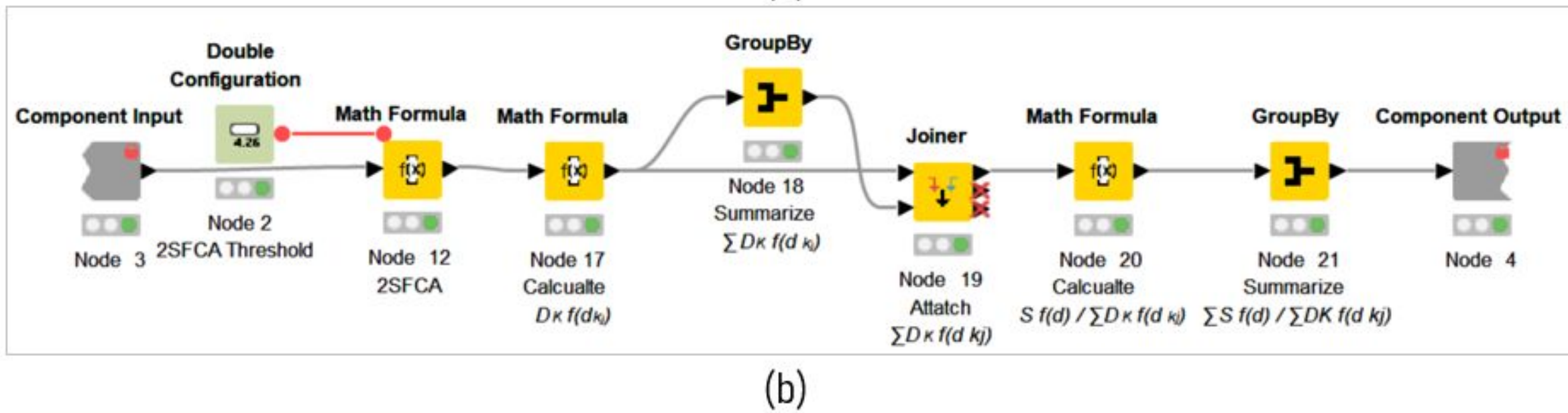
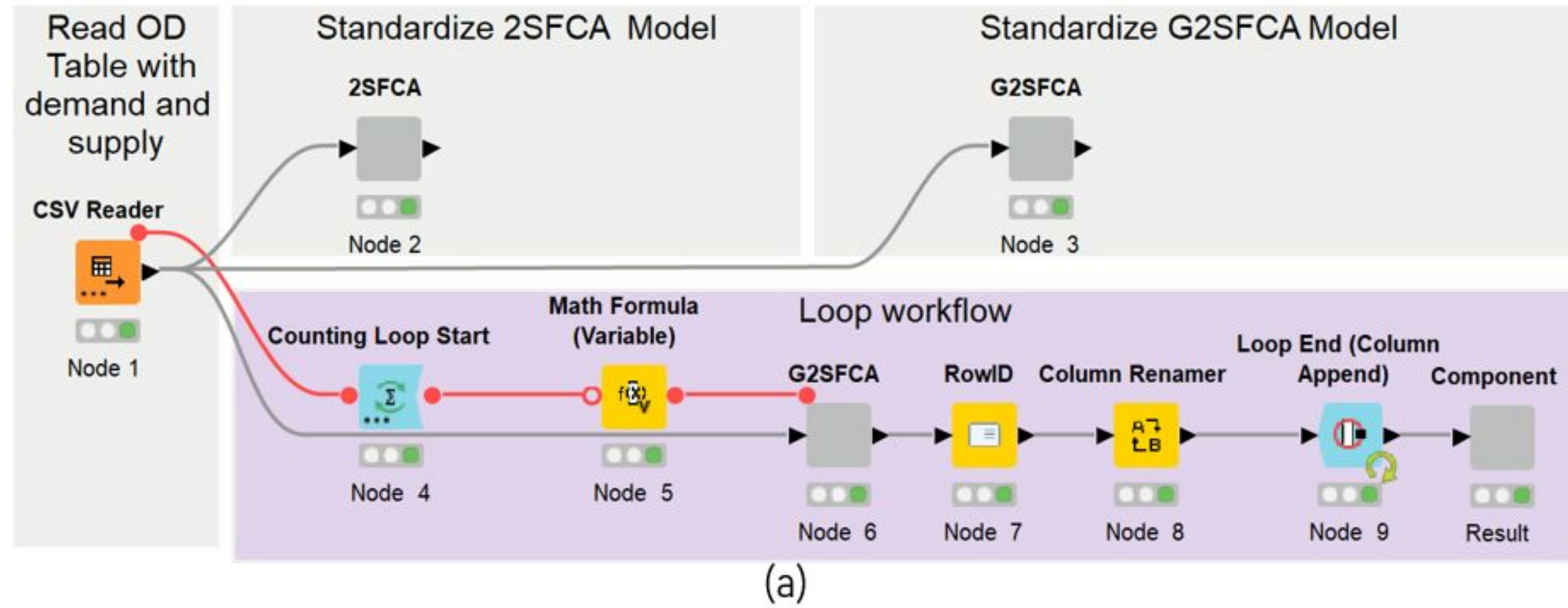


Figure 7: (a) A refined workflow for using component of 2SFCA and G2SFCA, and its sub-workflows inside the components of (b) 2SFCA Model and (c) G2SFCA

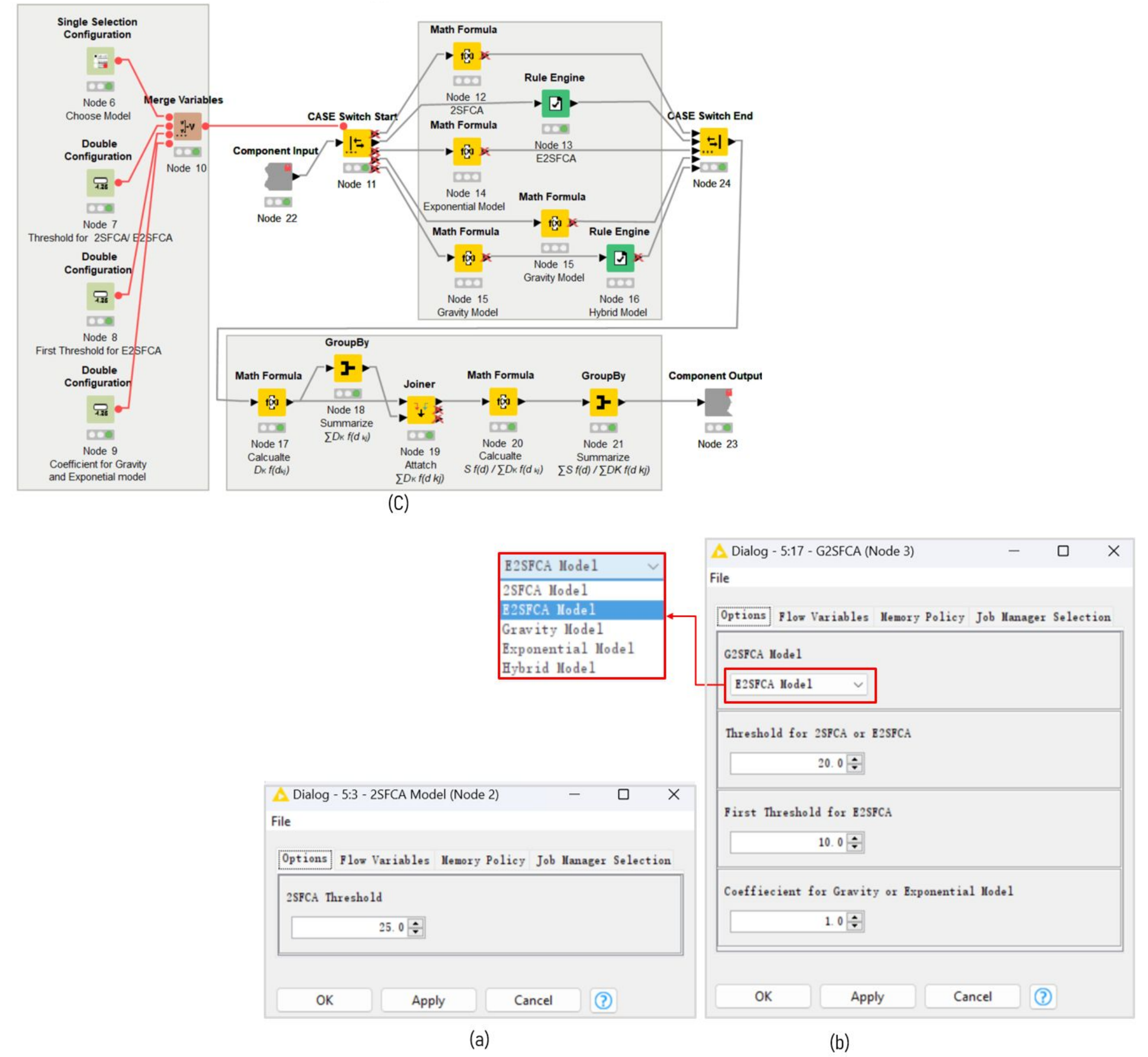


Figure 8: Interface of the components (a) 2SFCA and (b) G2SFCA

Knowledge tree of healthcare accessibility

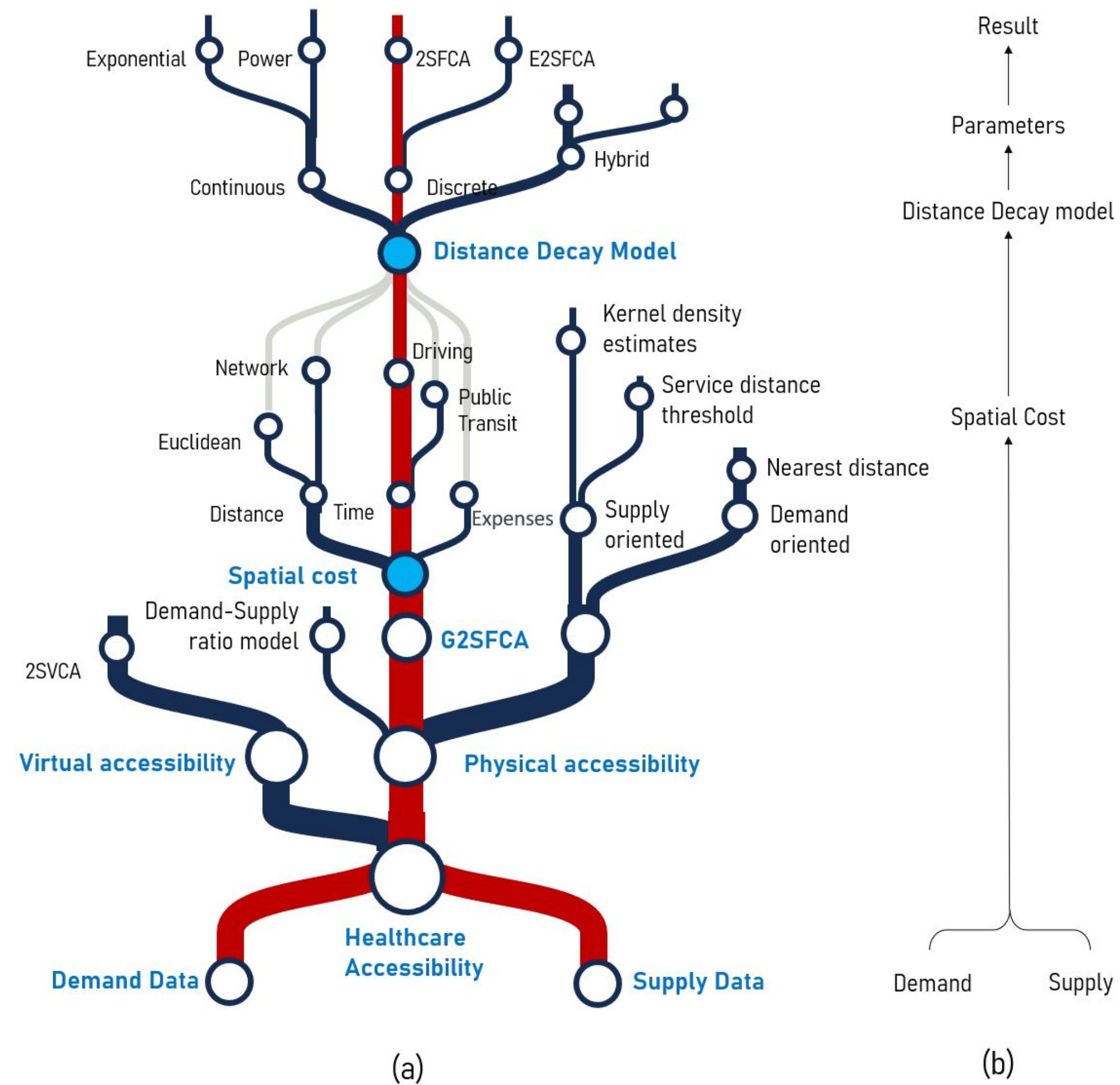




Figure 12. (a) Knowledge tree of healthcare accessibility, and (b) conceptual workflow for G2SFCA model

Executable Textbook in KNIME

Title
Objective
Methodology
Data

 Upload  Download  Refresh

Result Dashboard

Step 1: Preliminary exploration of Input Data



Explanation

Interoperable Text Input

Step 2: Model Parameter Setting and Adjustment

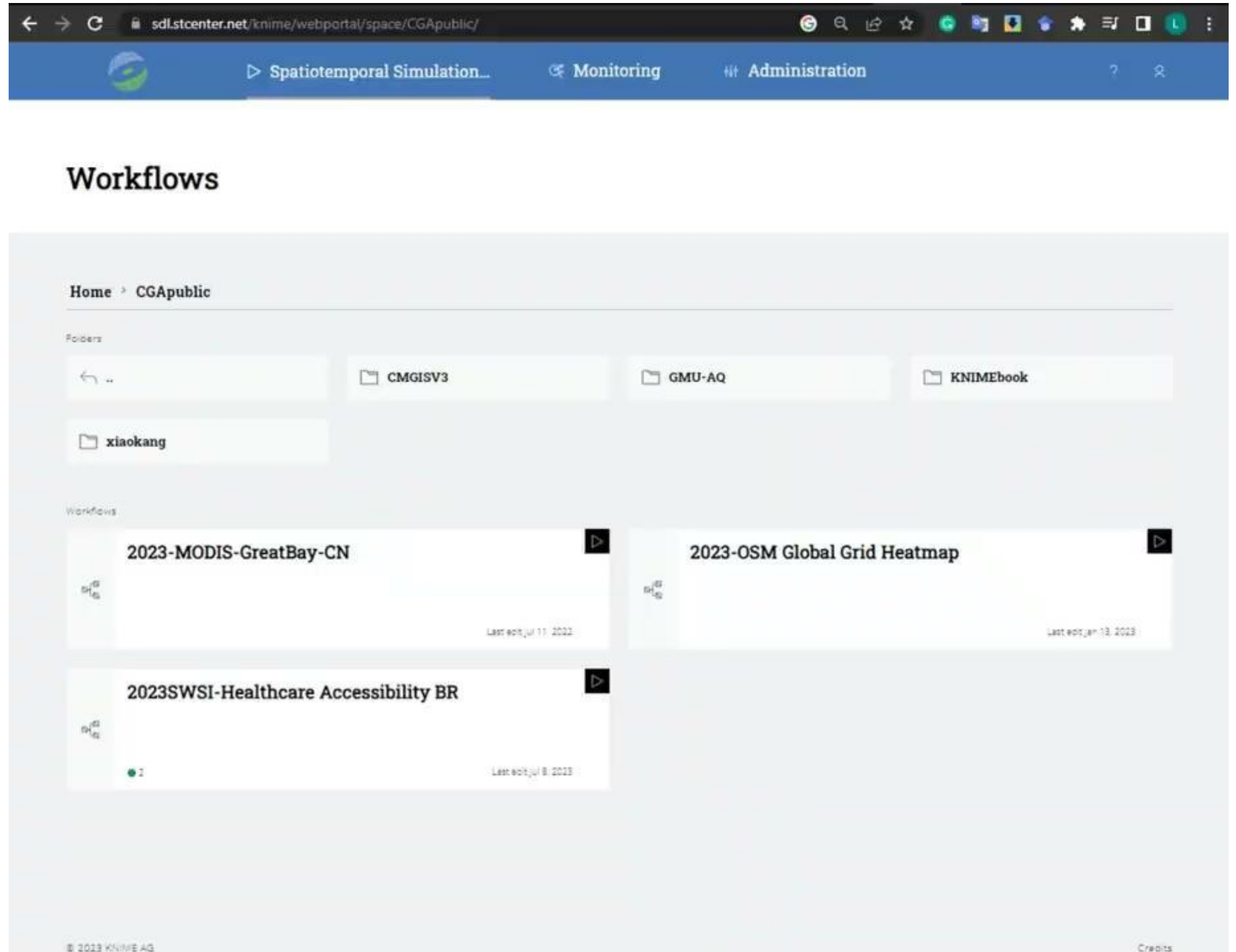
Parameter 1

Parameter

Step 3: Result based on fixed parameters

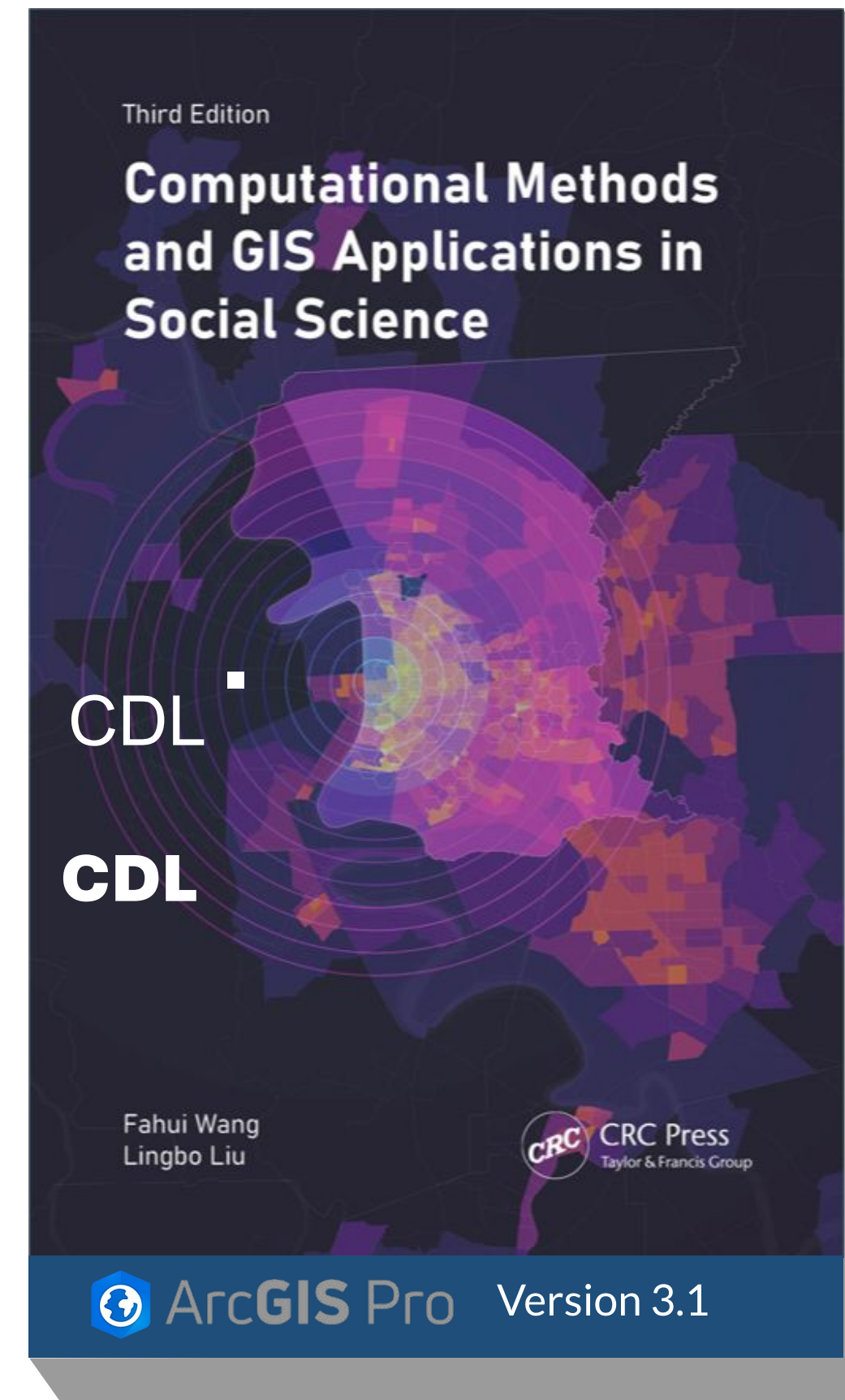
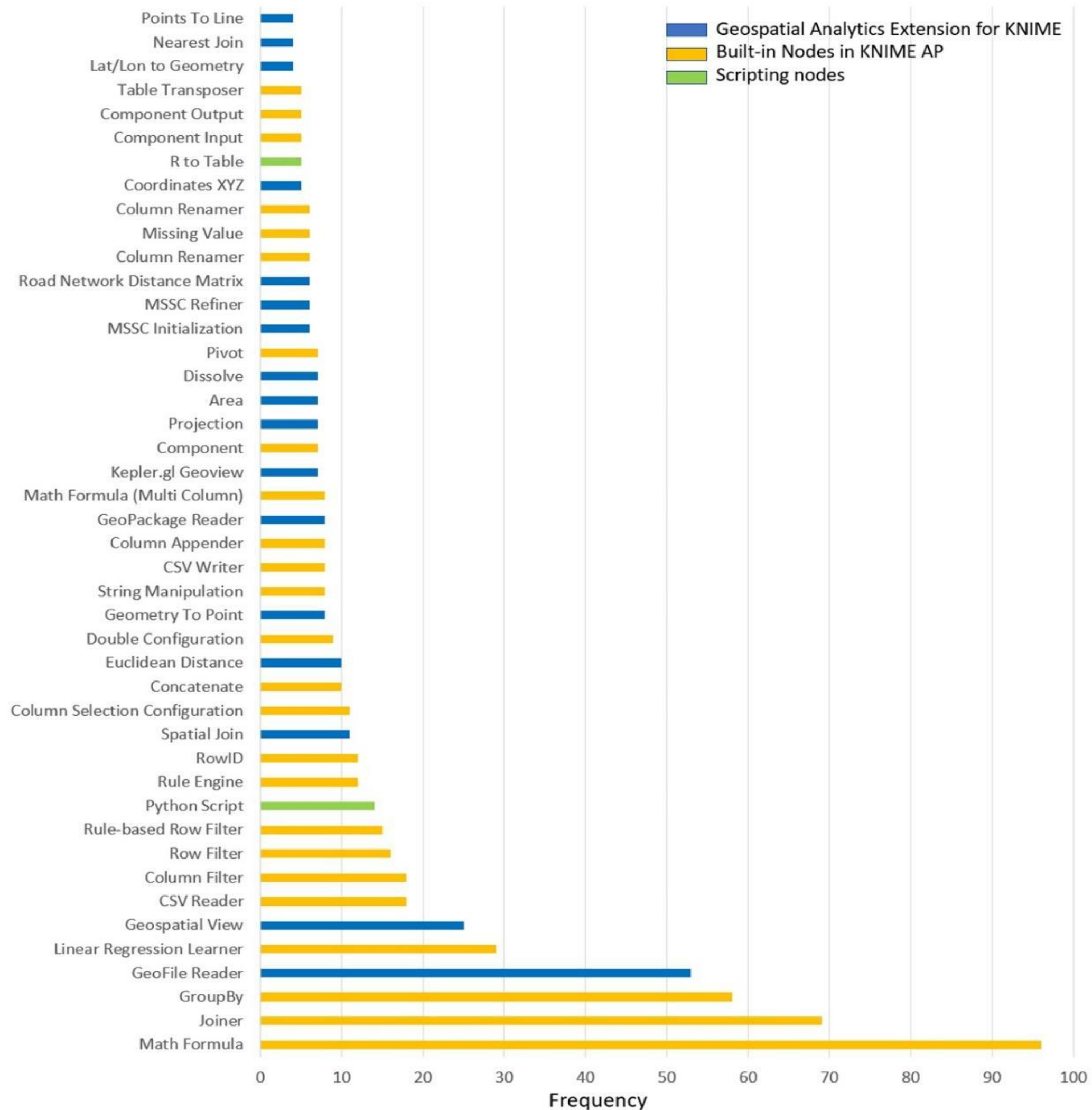


Explanation

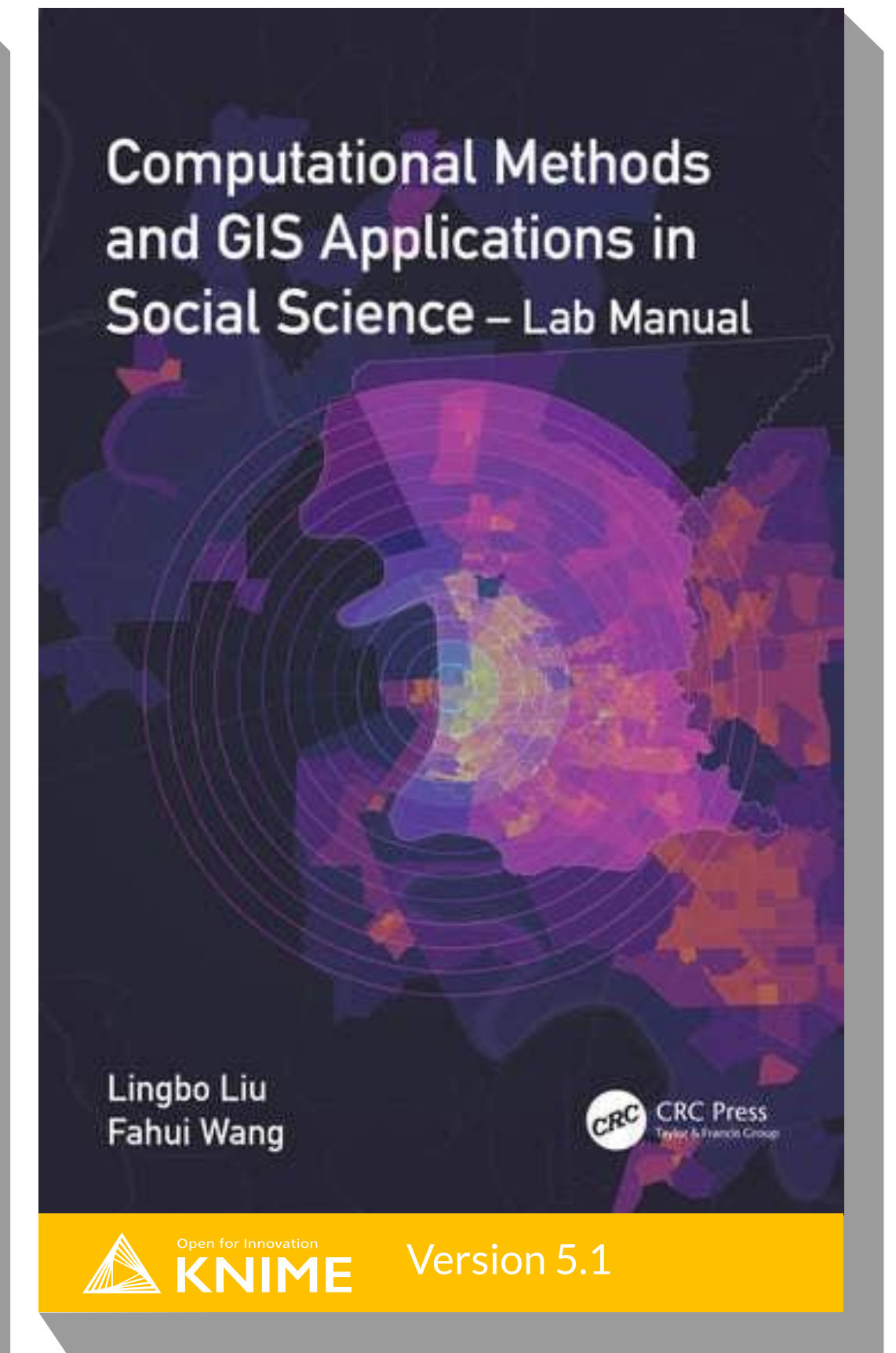


The screenshot shows a web browser window with the URL `sdl.stcenter.net/knime/webportal/space/CGApublic/`. The page title is "Spatiotemporal Simulation..." and the navigation menu includes "Monitoring" and "Administration". The main content area is titled "Workflows" and shows a breadcrumb "Home > CGApublic". Under "Folders", there are links for "CMGISV3", "GMU-AQ", "KNIMEbook", and "xiaokang". Under "Workflows", there are three workflow cards: "2023-MODIS-GreatBay-CN" (last edit: Jul 11, 2023), "2023-OSM Global Grid Heatmap" (last edit: Jan 13, 2023), and "2023SWSI-Healthcare Accessibility BR" (last edit: Jul 8, 2023). The footer contains "© 2023 KNIME AG" and "Credits".

Visual Programming nodes Comparison



Publish Date 8/15/2023



Publish Date 10/15/2023

Install KNIME and GAEK

<https://www.knime.com/downloads>

Download KNIME

Windows

Microsoft Defender SmartScreen may block download in its attempt to prevent malicious software installations. To solve the problem [click here](#).

KNIME Analytics Platform for Windows (installer) <i>The installer adds an icon to the desktop and suggests suitable memory settings</i>	Download
KNIME Analytics Platform for Windows (self-extracting archive) <i>The self-extracting archive only creates a folder holding the KNIME installation</i>	Download
KNIME Analytics Platform for Windows (zip archive)	Download

Linux

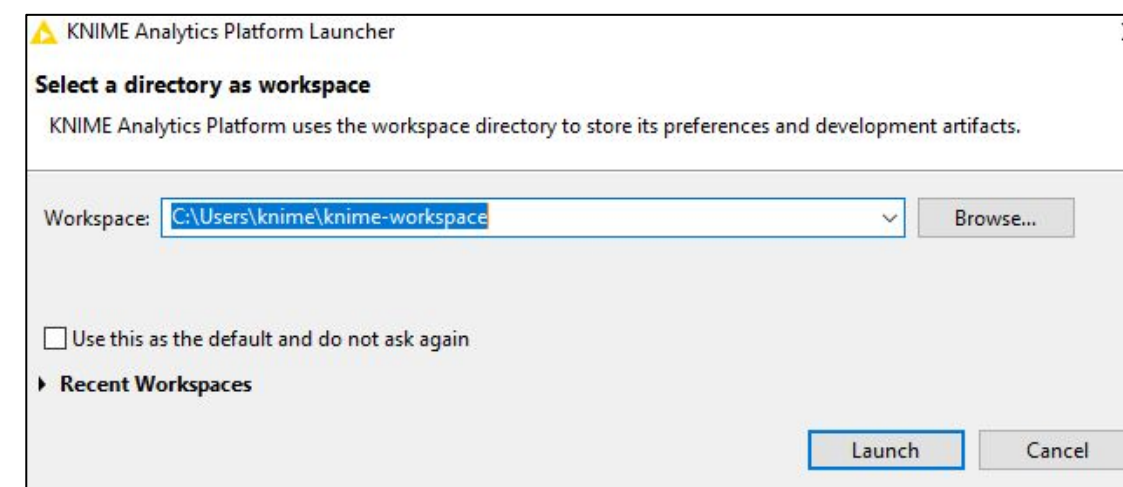
KNIME Analytics Platform for Linux	Download
------------------------------------	--------------------------

Mac

KNIME Analytics Platform for macOS x86_64 (Intel)	Download
KNIME Analytics Platform for macOS arm64 (Apple silicon)	Download

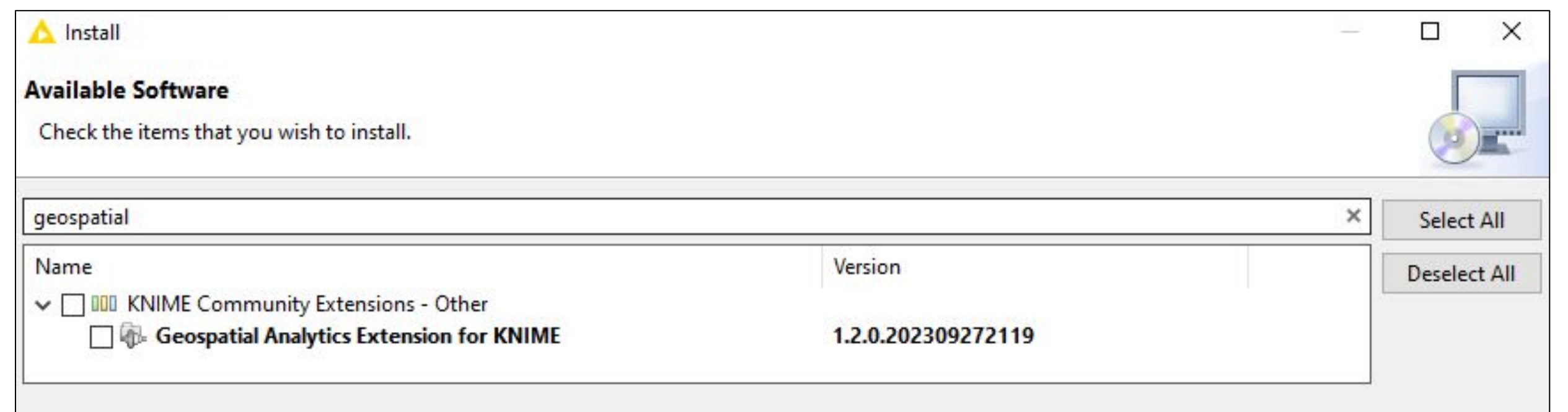
KNIME Workspace

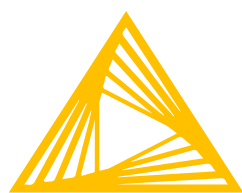
folder/directory in which workflows (and potentially data files) are stored for the current KNIME session. Portable (just like KNIME).





```
-Xmx2048m
-Dorg.eclipse.swt.browser.IEVersion=11001
-Dsun.awt.noerasebackground=true
-Dequinox.statechange.timeout=30000
-Darrow.enable_unsafe_memory_access=true
-Darrow.memory.debug allocator=false
-Darrow.enable_null_check_for_get=false
--add-opens=java.security.jgss/sun.security.jgss.krb5=ALL-UNNAMED
--add-exports=java.security.jgss/sun.security.jgss=ALL-UNNAMED
--add-exports=java.security.jgss/sun.security.jgss.spi=ALL-UNNAMED
```

Install GAEK In KNIME> File> Install KNIME extension, input 'geo'





launch KNIME via the  Knime.exe

 knime.ini Xmx2048m -> Xmx8g



Acknowledgement



NSF
U/I CRC



Future Data Lab



Spatiotemporal
Innovation Center

<https://projects.iq.harvard.edu/chinadatalab>

<https://github.com/spatial-data-lab/knime-geospatial-extension>

